U.S. Fish and Wildlife Service
Land-Based Wind Energy Guidelines

Acknowledgements

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U.S. Fish and Wildlife Service

Land-Based Wind Energy Guidelines

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Introduction

As the United States moves to expand wind energy production, it also must maintain and protect the Nation's fish, wildlife, and their habitats, which wind energy production can negatively affect. As with all responsible energy development, wind energy projects should adhere to high standards for environmental protection. With proper diligence paid to siting, operations, and management of projects, it is possible to mitigate for adverse effects to fish, wildlife, and their habitats. This is best accomplished when the developer coordinates as early as possible with the Service and other stakeholders. Such coordination allows for the greatest range of development and mitigation options.

In response to increasing wind energy development in the United States, the U.S. Fish and Wildlife Service (Service) released a set of voluntary, interim guidelines for reducing adverse effects to fish and wildlife resources from wind energy projects for public comment in July 2003. After the Service reviewed the public comments, the Secretary of the Interior (Secretary) established a Federal Advisory Committee to provide recommendations to revise the guidelines related to land-based wind energy facilities. In March 2007, the Service announced in the *Federal Register* the establishment of the Wind Turbine Guidelines Advisory Committee (the Committee). The Committee submitted its final Recommended Guidelines (Recommendations) to the Secretary on March 4, 2010. The Service used the Recommendations to develop its draft Land-Based Wind Energy Guidelines.

The Service's Land-based Wind Energy Guidelines are founded upon a "tiered approach" for assessing potential adverse effects to wildlife species of concern and their habitats. The tiered approach is an iterative decision making process for collecting information in increasing detail; quantifying the possible risks of proposed wind energy projects to wildlife species of concern and habitats; and evaluating those risks to make siting, construction, and operation decisions. Subsequent tiers refine and build upon issues raised and efforts undertaken in previous tiers. At each tier, a set of questions is provided to help the developer evaluate the potential risk associated with developing a project at the given location. The tiered approach guides a developer's decision process as to whether or not the selected location is appropriate for wind development. This decision is related to site-specific conditions regarding potential species and habitat effects.

Briefly, the tiers address:

- Tier 1 – Preliminary evaluation or screening of potential sites (landscape-scale screening of possible project sites)

- Tier 2 – Site characterization (broad characterization of one or more potential project sites)

- Tier 3 – Pre-Construction monitoring and assessments (site-specific assessments at the proposed project site)

- Tier 4 – Post-construction monitoring of effects (to evaluate fatalities and other effects)

- Tier 5 – Research (to further evaluate direct and indirect effects, and assess how they may be addressed)

The Service urges voluntary adherence to the Guidelines (see page 11, *Service Expectations*) and frequent communication with the Service when planning and operating a facility.

The Guidelines are based on best available methods and metrics to help answer the questions posed at each tier. Research on wind energy effects on wildlife species of concern and their habitats is ongoing and new information is made available on a regular basis. Substantial variability can exist among project sites and as such, methods and metrics should be applied with the flexibility to address the varied issues that may occur on a site-by-site basis, while maintaining consistency in the overall tiered process. As research expands and provides new information, these methods and metrics will be updated to reflect current science.

Chapter 1

General Overview

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people. As part of this, we are charged with implementing statues including the Endangered Species Act, Migratory Bird Treaty Act, and Bald and Golden Eagle Protection Act. These statutes prohibit taking of federally listed species, migratory birds and eagles unless otherwise authorized. These Guidelines are intended to:

(1) Promote voluntary compliance with relevant wildlife laws and statutes;

(2) Encourage scientifically rigorous survey, monitoring, assessment, and research designs proportionate to the risk to species of concern;

(3) Produce potentially comparable data across the Nation;

(4) Avoid, minimize, and, if appropriate, compensate for potential adverse effects on species of concern and their habitats; and,

(5) Improve the ability to predict and resolve effects locally, regionally, and nationally.

The Service encourages project proponents to use the process described in these voluntary Land-based Wind Energy Guidelines (Guidelines) to address risks to species of concern. The Service intends that these Guidelines, when used in concert with the appropriate regulatory tools, will be the best practical approach for conservation of species of concern.

Statutory Authorities

These draft Guidelines are not intended nor shall they be construed to limit or preclude the Service from exercising its authority under any law, statute, or regulation, or from conducting enforcement action against any individual, company, or agency. They are not meant to relieve any individual, company, or agency of its obligations to comply with any applicable federal, state, tribal, or local laws, statutes, or regulations.

Ultimately it is the responsibility of those involved with the planning, design, construction, operation, maintenance, and decommissioning of wind projects to conduct relevant fish, wildlife, and habitat evaluation (e.g., siting guidelines, risk assessment, etc.) and determine, which, if any, species may be affected. The results of these analyses will inform all efforts to achieve compliance with the appropriate jurisdictional statutes. Project proponents are responsible for complying with applicable state and local laws.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute, meaning that proof of intent, knowledge, or negligence is not an element of an MBTA violation. The statute's language is clear that most actions resulting in a "taking" or possession (permanent or temporary) of a protected species, in the absence of regulatory authorization, are a violation of the MBTA.

The MBTA states, "Unless and except as permitted by regulations … it shall be unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, kill … possess, offer for sale, sell … purchase … ship, export, import … transport or cause to be transported … any migratory bird, any part, nest, or eggs of any such bird …. [The Act] prohibits the taking, killing, possession, transportation, import and export of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior." 16 U.S.C. 703. The word "take" is defined by regulation as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." 50 C.F.R. 10.12.

The MBTA provides criminal penalties for persons who commit any of the acts prohibited by the statute in section 703 on any of the species protected by the statute. *See* 16 U.S.C. 707. The Service maintains a list of all species protected by the MBTA at 50 C.F.R. 10.13. This list includes over one thousand species of migratory birds, including eagles and other raptors, waterfowl, shorebirds, seabirds, wading birds, and passerines. The MBTA does not protect introduced species such as the house (English) sparrow, European starling, rock dove (pigeon), Eurasian collared-dove, and non-migratory upland game birds. The Service maintains a list of introduced species not protected by the Act. *See* 70 Fed. Reg. 12,710 (Mar. 15, 2005).

Bald and Golden Eagle Protection Act

Under authority of the Bald and Golden Eagle Protection Act (BGEPA), 16 U.S.C. 668–668d, bald eagles and golden eagles are afforded additional legal protection. BGEPA prohibits the take, sale, purchase, barter, offer of sale, purchase, or barter, transport, export or import, at any time or in any manner , of any bald or golden eagle, alive or dead, or any part, nest, or egg thereof. 16 U.S.C. 668. BGEPA also defines take to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb," 16 U.S.C. 668c, and includes criminal and civil penalties for violating the statute. *See* 16 U.S.C. 668. The Service further defined the term "disturb" as agitating or bothering an eagle to a degree that causes, or is likely to cause, injury, or either a decrease in productivity or nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior. 50 C.F.R. 22.3. BGEPA authorizes the Service to permit the take of eagles for certain purposes and under certain circumstances, including scientific or exhibition purposes, religious purposes of Indian tribes, and the protection of wildlife, agricultural, or other interests, so long as that take is compatible with the preservation of eagles. 16 U.S.C. 668a.

In 2009, the Service promulgated a final rule on two new permit regulations that, for the first time, specifically authorize the incidental take of eagles and eagle nests in certain situations under BGEPA. *See* 50 C.F.R. 22.26 & 22.27. The permits will authorize limited, non-purposeful (incidental) take of bald and golden eagles; authorizing individuals, companies, government agencies (including tribal governments), and other organizations to disturb or otherwise take eagles in the course of conducting lawful activities such as operating utilities and airports. Most permits issued under the new regulations would authorize disturbance. In limited cases, a permit may authorize the take of eagles that results in death or injury. Removal of active eagle nests would usually be allowed only when it is necessary to protect human safety or the eagles. Removal of inactive nests can be authorized when necessary to ensure public health and safety, when a nest is built on a human-engineered structure rendering it inoperable, and when removal is necessary to protect an interest in a particular locality, but only if the take or mitigation for the take will provide a clear and substantial benefit to eagles.

To facilitate issuance of permits under these new regulations, the Service has drafted Eagle Conservation Plan (ECP) Guidance. The ECP Guidance is intended to be compatible with these Land-Based Wind Energy Guidelines. The Guidelines guide developers through the process of project development and operation. If eagles are identified as a potential risk at a project site, developers are strongly encouraged to refer to the ECP Guidance. The ECP Guidance describes specific actions that are recommended to comply with the regulatory requirements in BGEPA for an eagle take permit as described in 50 CFR 22.26. The ECP Guidance is intended to provide a national framework for assessing and mitigating risk specific to eagles through development of ECPs. The final ECP will be made available to the public through the Service's website when it is finalized.

Endangered Species Act

The Endangered Species Act (16 U.S.C. 1531–1544; ESA) was enacted by Congress in 1973 in recognition that many of our Nation's native plants and animals were in danger of becoming extinct. The ESA directs the Service to identify and protect these endangered and threatened species and their critical habitat, and to provide a means to conserve their ecosystems. To this end, federal agencies are directed to utilize their authorities to conserve listed species, and ensure that their actions are not likely to jeopardize the continued existence of these species or destroy or adversely modify their critical habitat. Federal agencies are encouraged to do the same with respect to "candidate" species that may be listed in the near future. The law is administered by the Service and the Commerce Department's National Marine Fisheries Service (NMFS).

The Service has primary responsibility for terrestrial and freshwater organisms, while NMFS generally has responsibility for marine species. These two agencies work with other agencies to plan or modify federal projects so that they will have minimal impact on listed species and their habitats. Protection of species is also achieved through partnerships with the states, with federal financial assistance and a system of incentives available to encourage state participation. The Service also works with private landowners, providing financial and technical assistance for management actions on their lands to benefit both listed and non-listed species.

Section 9 of the ESA makes it unlawful for a person to "take" a listed species. Take is defined as "... to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." 16 U.S.C. 1532(19). The terms harass and harm are further defined in our regulations. *See* 50 C.F.R. 17.3. However, the Service may authorize "incidental take" (take that occurs as a result of an otherwise legal activity) in two ways.

Take of federally listed species incidental to a lawful activity may be authorized through formal consultation under section 7(a)(2) of the ESA, whenever a federal agency, federal funding, or a federal permit is involved. Otherwise, a person may seek an incidental take permit under section 10(a)(1)(B) of the ESA upon completion of a satisfactory habitat conservation plan (HCP) for listed species. For more information regarding formal consultation and HCPs, please see the Endangered Species Consultation Handbook at http://www.fws.gov/endangered/esa-library/index.html#consultations and the Service's HCP website, http://www.fws.gov/endangered/what-we-do/hcp-overview.html."

Service Expectations

Consideration of the Guidelines in MBTA and BGEPA Enforcement

The Service urges voluntary adherence to the guidelines and communication with the Service when planning and operating a facility. In the context of voluntary guidelines, it is not possible to absolve individuals or companies from MBTA or BGEPA liability, but the Service will regard such voluntary adherence and communication as evidence of due care with respect to avoiding, minimizing, and mitigating significant adverse impacts to species protected under the MBTA and BGEPA, and will take such adherence and communication fully into account when exercising its discretion with respect to any potential referral for prosecution related to the death of or injury to any such species. Each developer and operator will be responsible for maintaining internal records sufficient to demonstrate adherence to the guidelines, and responsiveness to communications from the Service. Examples of these records could include: studies performed in the implementation of the tiered approach; an internal or external review or audit process; an Avian and Bat Protection Plan; or a wildlife management plan. The Service retains its existing authority to inspect and assess the sufficiency of those records.

With regard to eagles, application of these considerations will only apply when there is no anticipated take of eagles. If Tiers 1, 2, and/or 3 identify a potential to take eagles, developers should develop an ECP and, if necessary, apply for a take permit.

If a developer and operator are not the same entity, the Service expects the operator to maintain sufficient records to demonstrate adherence to the Guidelines.

Voluntary Adherence and Communication

For projects commencing after the effective date of the guidelines, "voluntary adherence and communication" shall mean that the developer has applied the guidelines, including the tiered approach, through site selection, design, construction, operation and post-operation phases of the project, and has communicated with Service and considered its advice. While the advice of the Service is not binding, neither can it simply be reviewed and rejected without a contemporaneously documented reasoned justification, at least if the developer seeks to have the benefit of the enforcement discretion provisions of these guidelines. Instead, proper consideration of the advice of the Service entails contemporaneous documentation of how the developer evaluated that advice and the reasons for any departures from it. Although the guidelines leave decisions up to the developer, the Service retains authority to verify that developer efforts to avoid, minimize, and mitigate impacts are sufficient, and to refer for prosecution any take of migratory birds that it believes to be reasonably related to lack of responsiveness to Service communications or insufficient compliance with the guidelines.

Phase-In for Using the Guidelines

The Service recognizes that hundreds of wind energy projects exist and are being planned. We recommend that wind project developers and operators contact local Service offices to work with them regarding how to apply this tiered approach to operating projects and projects in various stages of planning. Tiers 1 through 5 should be applied at the appropriate tier based on the stage of development or construction of the project. The Service is aware that it will take time to train Service and other personnel, including wind project developers and their biologists, in the implementation of the Guidelines. The Service will make every effort to develop and provide training as soon as possible after publication of the final Guidelines.

The Service encourages use of the guidelines and adoption of the tiered approach by future and existing projects. Accordingly, all projects that commence after the effective date should apply the tiered approach to all phases of the project. However, projects that have already commenced are not expected to start over or return to the beginning of a specific tier. Instead, these projects should implement those portions of the guidelines relevant to the continuing phases of the project. For projects that are already operational prior to the effective date, they should adhere to the recommendations in Tier 4, and, if applicable, Tier 5.

Scope and Project Scale of the Guidelines

The Guidelines are designed for "utility- scale" land-based wind energy projects to reduce potential impacts to species of concern, regardless of whether they are proposed for private or public lands. While these Guidelines are designed for utility- scale wind projects, the general principles may also apply to distributed and community-scale wind energy projects. Developers should contact the Service to determine applicability of the Guidelines to their particular project. Offshore wind energy projects may involve another suite of effects and analyses not addressed here.

The Service considers a "project" to include all phases of wind energy development, including, but not limited to, prospecting, site assessment, construction, operation, and decommissioning, as well as all associated infrastructure and interconnecting electrical lines. A "project site" is the land and airspace where development occurs or is proposed to occur, including the turbine pads, roads, power distribution and transmission lines on or immediately adjacent to the site; buildings and related infrastructure, ditches, grades, culverts; and any changes or modifications made to the original site before develop occurs. Project evaluations should consider all potential effects to species of concern, which includes 1) species protected by the MBTA, BGEPA, and ESA, designated by law, regulation or other formal process for protection and/or management by the relevant agency or other authority, or has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the project. These draft Guidelines are not designed to address power transmission beyond the point of interconnection to the transmission system.

The tiered approach is designed to lead to the appropriate amount of evaluation in proportion to the anticipated level of risk that a project may pose to wildlife and their habitats. Study plans and the duration and intensity of study efforts should be tailored specifically to the unique characteristics of each site and the corresponding potential for significant adverse impacts on wildlife and their habitats as determined through the tiered approach. In particular, the risk of adverse impacts to wildlife and their habitats tends to be a function of site location, not necessarily the size of the project. A small project may pose greater risk to wildlife than a larger site in a less sensitive location, and may therefore require more pre- and post-construction studies than the larger site. This is why the tiered approach begins with an examination of the potential location of the project, not the size of the project. In all cases, study plans and selection of appropriate study methods and techniques may be tailored to the relative scale, location and potential for significant adverse impacts of the proposed site.

Service Review Period

The Service is committed to providing timely responses. The Service has determined that Field Offices have 60 calendar days to respond to a request by a wind energy developer to review and comment on proposed site locations, pre- and post-construction study designs, and draft Avian and Bat Protection Plans. The request should be in writing to the field office and copied to the Regional Office with information about the proposed project, location(s) under consideration, and point of contact. The request should contain a description of the information needed from the Service. The Service will provide a response, even if it is to notify a developer of additional review time, within the 60 day review period. If the Service does not respond within 60 days of receipt of the document, then the developer can proceed through Tier 3 without waiting for Service input. If the Service provides comments at a later time, the developer should incorporate the comments if feasible. It is particularly important that developers share Avian and Bat Protection and/or other Plans with the Service prior to construction.

The tiered approach allows a developer in certain limited circumstances to move directly from Tier 2 to construction. The developer should notify the Service of this decision and to give the Service 60 calendar days to comment on the proposed project prior to initiating construction activities.

Introduction to the Decision Framework Using a Tiered Approach

The tiered approach provides a decision framework for collecting information in increasing detail to evaluate risk and make siting and operational decisions. It provides the opportunity for evaluation and decision-making at each tier, enabling a developer to abandon or proceed with project development, or to collect additional information if required. This approach does not require that every tier, or every element within each tier, be implemented for every project. Instead, it allows efficient use of developer and wildlife agency resources with increasing levels of effort until sufficient information and the desired precision is acquired for the risk assessment.

Application of the Tiered Approach and Possible Outcomes

Figure 1 ("General Framework for Minimizing Impacts of Wind Development on Wildlife in the Context of the Siting and Development of Wind Energy Projects") illustrates the tiered approach, which consists of up to five iterative stages, or tiers:

Tier 1 – Preliminary evaluation or screening of potential sites

Tier 2 – Site characterization

Tier 3 – Field studies to document site wildlife conditions and predict project impacts

Tier 4 – Post-construction monitoring

Tier 5 – Other post-construction studies

At each tier, potential issues associated with developing or operating a project are identified and questions formulated to guide the decision process. Chapters Two through Six outline the questions to be posed at each tier, and describes recommended methods and metrics for gathering the data needed to answer those questions.

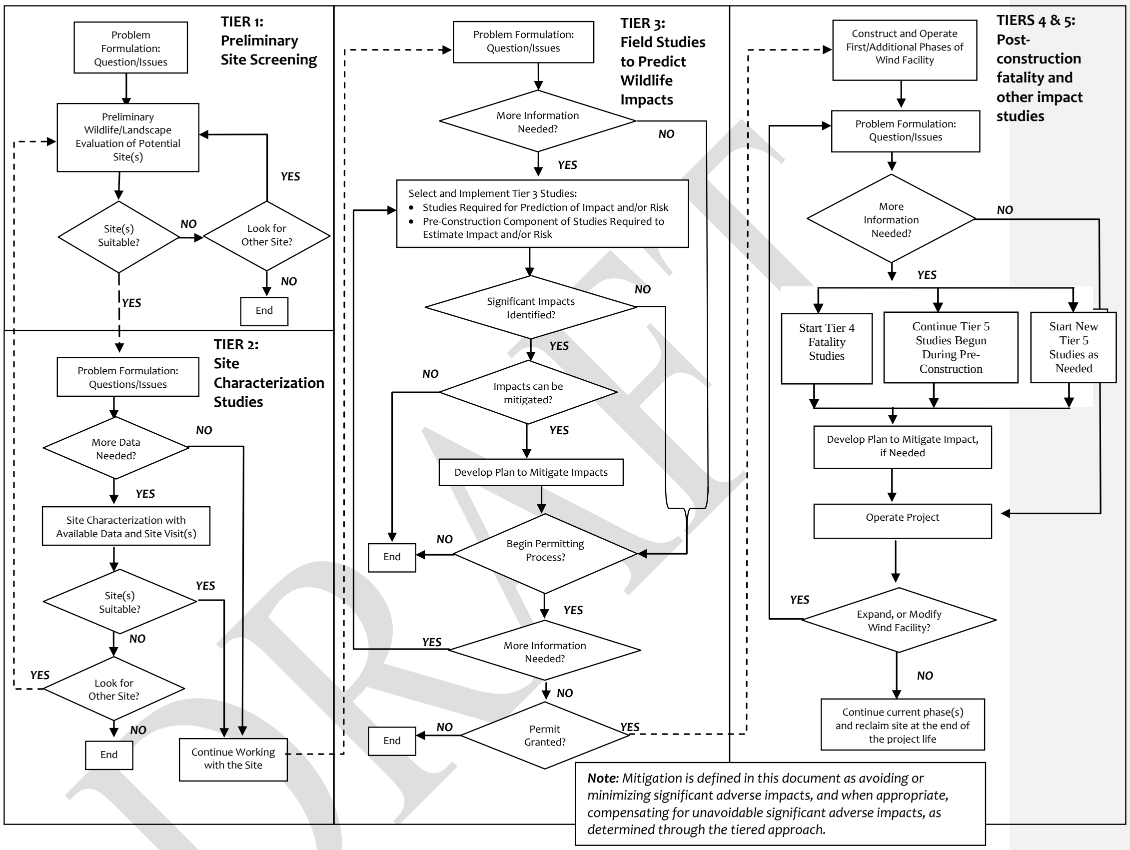
If sufficient data are available at a particular tier, the following outcomes are possible based on analysis of the information gathered:

1. The project site is abandoned because the risk is considered unacceptable.
2. The project proceeds to the next tier in the development process without additional data collection.

3. An action or combination of actions, such as project modification, mitigation, or specific post-construction monitoring, is indicated.

If data are deemed insufficient at a tier, more intensive study is conducted in the subsequent tier until sufficient data are available to make a decision to abandon the project, modify the project, or proceed with the project.

Figure 1. General Framework for Minimizing Impacts of Wind Development on Wildlife in the Context of the Siting and Development of Wind Energy Projects [1]



[1] Figure 1 presents a generalization of decision points a developer may face during the life of a wind energy project. At any point in this process, the need for permits under Federal regulation (e.g., ESA Sections 7 & 10, BGEPA, CWA Section 404) or under State or local regulation, may become necessary. Developers should work with the appropriate regulatory entities to obtain permits as soon as the need for permits is identified.

Application of the Tiered Approach and Risk Assessment

Risk is the likelihood that adverse impacts will occur to individuals or populations of species of concern as a result of wind energy development and operation. Estimates of fatality risk can be used in a relative sense, allowing comparisons among projects, alternative development designs, and in the evaluation of potential risk to populations. Because there are relatively few methods available for direct estimation of risk, a weight-of-evidence approach is often used (Anderson et al. 1999). Until such time that reliable risk predictive models are developed, estimates of risk would typically be qualitative, but would be based upon quantitative site information.

Risk can also be defined in the context of populations, but the calculation is more complicated as it could involve estimating the reduction in population viability as indicated by demographic metrics such as growth rate, size of the population, or survivorship, either for local populations, metapopulations, or entire species. For most populations, risk cannot easily be reduced to a strict metric, especially in the absence of population viability models for most species. Consequently, estimating the quantitative risk to populations is usually beyond the scope of project studies due to the difficulties in evaluating these metrics, and therefore risk assessment will be qualitative. Risk to habitat is a component of the evaluation of population risk. In this context, the estimated loss of habitat is evaluated in terms of the potential for population level effects (e.g., reduced survival or reproduction).

The assessment of risk should synthesize sufficient data collected at a project to estimate exposure and predict impact for individuals and their habitats for the species of concern, with what is known about the population status of these species, and in communication with the relevant wildlife agency and industry wildlife experts. Predicted risk of these impacts could provide useful information for determining appropriate mitigation measures if determined to be necessary. In practice in the tiered approach, risk assessments conducted in Tiers 1 and 2 require less information to reach a risk-based decision than those conducted at higher tiers.

Cumulative Impacts of Project Development

Cumulative impacts are the comprehensive effect on the environment that results from the incremental impact of a project when added to other past, present, and reasonably foreseeable future actions. Consideration of cumulative impacts should be incorporated into the wind energy planning process as early as possible to improve decisions. To achieve that goal, it is important that agencies and organizations take the following actions to improve cumulative impacts analysis: review the range of development-related significant adverse impacts, determine which species of concern or their habitats within the landscape are most at risk of significant adverse impacts from wind development in conjunction with other reasonably foreseeable significant adverse impacts, and make that data available for regional or landscape level analysis. The magnitude and extent of the impact on a resource depend on whether the cumulative impacts exceed the capacity for resource sustainability and productivity.

Federal agencies are required to include a cumulative impacts analysis in their NEPA review, including any energy projects that require a federal permit or have any other federal nexus. The federal action agency coordinates with the developer to obtain the necessary information for the NEPA review and cumulative impacts analysis. To avoid project delays, federal and state agencies are encouraged to use existing wildlife data for the cumulative impacts analysis until improved data are available.

Where there is no federal nexus, individual developers are not expected to conduct their own cumulative impacts analysis. However, a cumulative impacts analysis would help developers and other stakeholders better understand the significance of potential impacts on wildlife and habitats. Developers are encouraged to coordinate with federal and state agencies early in the project planning process to access any existing information on the cumulative impacts of individual projects on species and habitats at risk, and to incorporate it into project development and any necessary wildlife studies.

Applicability of Adaptive Management

Adaptive management is an iterative learning process producing improved understanding and improved management over time (Williams et al 2007). The Department of the Interior determined that its resource agencies, and the natural resources they oversee, could benefit from adaptive management. Use of adaptive management in the DOI is guided by the DOI Policy on

Adaptive Management. DOI adopted the National Research Council's 2004 definition of adaptive management, which states:

> Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

This definition gives special emphasis to uncertainty about management effects, iterative learning to reduce uncertainty, and improved management as a result of learning.

When using adaptive management, project proponents will generally select several alternative management approaches to design, implement, and test. The alternatives are generally incorporated into sound experimental designs. Monitoring and evaluation of each alternative helps in deciding which alternative is more effective in meeting objectives, and informs adjustments to the next round of management decisions.

For adaptive management to be effective there must be agreement to adjust management and/or mitigation measures if monitoring indicates that anticipated impacts are being exceeded. The agreement should include a timeline for periodic reviews and adjustments as well as a mechanism to consider and implement additional mitigation measures as necessary after the project is developed. The Service recommends use of adaptive management. The use of adaptive management should be discussed among the project proponent, Service field office, and the state wildlife agency. The DOI Adaptive Management Technical Guide is located on the web at: www.doi.gov/initiatives/AdaptiveManagement/index.html.

Coordination with Other Federal Agencies

Other Federal agencies, such as the Bureau of Land Management, National Park Service, U.S. Department of Agriculture Forest Service and Rural Utility Service, and Department of Energy are often interested in and involved with wind project developments. These agencies have a variety of expertise and authorities they implement. State and local agencies and Tribes also have additional interests and knowledge. The Service recommends that wind project developers contact these agencies early in the tiered process and work closely with them throughout project planning and development to assure that projects address issues of concern to those agencies.

Relationship to Other Guidelines

These Guidelines replace the Service's 2003 interim voluntary guidelines. The Service intends that these Guidelines, when used in concert with the appropriate regulatory tools, will be the best practical approach for conservation of species of Federal trust responsibility**.** For instance, when developers encounter an endangered or threatened species, they should comply with Section 7 or 10 of the ESA to obtain incidental take authorization. Other federal, state, tribal and local governments may use these Guidelines to complement their efforts to address wind energy development/fish and wildlife interactions. They are not intended to supplant existing regional or local guidance, or landscape-scale tools for conservation planning, but were developed to provide a means of improving consistency with the goals of the wildlife statutes that the Service is responsible for implementing. The Service will continue to work with states, tribes, and other local stakeholders on map-based tools, decision-support systems, and other products to help guide future development and conservation. Additionally, project proponents should utilize any relevant guidance of the appropriate jurisdictional entity, which will depend on the species and resources potentially affected by proposed development

Chapter 2

Tiered Approach and Tier 1 – Preliminary Site Evaluation

This chapter briefly describes the tiered approach, with subsequent chapters outlining BMPs during site construction, retrofitting, repowering and decommissioning phases of a project. The five tiers are:

Tier 1 – Preliminary evaluation or screening of potential sites

Tier 2 – Site characterization

Tier 3 – Field studies to document site wildlife conditions and predict project impacts

Tier 4 – Post-construction monitoring

Tier 5 – Other post-construction studies and research

The first three tiers correspond to the pre-construction evaluation phase of wind energy development. At each of the three tiers, the Guidelines provide a set of questions that developers attempt to answer, followed by recommended methods and metrics to use in answering the questions. Some questions are repeated at each tier, with successive tiers requiring a greater investment in data collection to answer certain questions. For example, while Tier 2 investigations may discover some existing information on federal or state-listed species and their use of the proposed development site, it may be necessary to collect empirical data in Tier 3 studies to determine the presence of federal or state-listed species.

The decision to proceed to the next tier is made by the developer. Although the decision to proceed to the next tier is ultimately that of the developers, early communication with the Service will provide verification whether the Service agrees with the developer's decision and/or approach. The decision is based on whether all questions identified in the tiers have been adequately answered and whether the methods for arriving at the answers were appropriate for the site selected and the risk posed to species of concern and their habitats.

Tier 1 - Preliminary Evaluation or Screening of Potential Sites

For developers taking a first look at a broad geographic area, a preliminary evaluation of the general ecological context of a potential site or sites can serve as useful preparation for coordination with the federal, state, tribal, and/or local agencies. The Service is available to assist wind energy project developers to identify potential wildlife and habitat issues and should be contacted as early as possible in the company's planning process. With this internal screening process, the developer can begin to identify broad geographic areas of high sensitivity due to the presence of: 1) large blocks of intact native landscapes, 2) intact ecological communities, 3) fragmentation-sensitive species' habitats, or 4) other important landscape-scale wildlife values. Tier 1 may be used in any of the following three ways:

1. To identify regions where wind energy development poses substantial risks to species of concern or their habitats, including the fragmentation of large-scale habitats and threats to regional populations of federal- or state-listed species.
2. To "screen" a landscape or set of multiple potential sites to avoid those with the highest habitat values.
3. To begin to determine if a single identified potential site poses serious risk to species of concern or their habitats.

Tier 1 can offer early guidance about the sensitivity of the site within a larger landscape context; it can help direct development away from sites that will be associated with additional study need, greater mitigation requirements, and uncertainty; or it can identify those sensitive resources that will need to be studied further to determine if the site can be developed without significant adverse impacts to the species of concern or local population(s). This may facilitate discussions with the federal, state, tribal, and/or local agencies in a region being considered for development. In some cases, Tier 1 studies could reveal serious concerns indicating that a site should not be developed.

Development in some areas may be precluded by federal law. This designation is separate from a determination through the tiered approach that an area is not appropriate for development due to feasibility, ecological reasons, or other issues. Developers are encouraged to visit Service databases or other available information during Tier 1 or Tier 2 to see if a potential wind energy area is precluded from development by federal law. Some areas may be protected from development through state or local laws or ordinances, and the appropriate agency should be contacted accordingly. The local Service office is available to answer questions regarding the designation and how it may apply to wind energy development.

Some areas may be inappropriate for large scale development because they have been recognized according to scientifically credible information as having high wildlife value, based solely on their ecological rarity and intactness (e.g., Audubon Important Bird Areas, The Nature Conservancy portfolio sites, state wildlife action plan priority habitats). It is important to identify such areas through the tiered approach, as reflected in Tier 1, Question 2 below. Many of North America's native landscapes are greatly diminished, with some existing at less than 10 percent of their pre-settlement occurrence. Herbaceous sub-shrub steppe in the Pacific Northwest and old growth forest in the Northeast are representative of such diminished native resources. Important remnants of these landscapes are identified and documented in various databases held by private conservation organizations, state wildlife agencies, and, in some cases, by the Service. Developers should collaborate with such entities specifically about such areas in the vicinity of a prospective project site.

Tier 1 Questions

Questions at each tier help determine potential environmental risks at the landscape scale for Tier 1 and project scale for Tiers 2 and 3. Suggested questions to be considered for Tier 1 include:

1. Are there species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?
2. Does the landscape contain areas where development is precluded by law or areas designated as sensitive according to scientifically credible information? Examples of designated areas include, but are not limited to: “areas of scientific importance;” “areas of significant value;” federally-designated critical habitat; high-priority conservation areas for non-government organizations (NGOs); or other local, state, regional, federal, tribal, or international categorizations.
3. Are there known critical areas of wildlife congregation, including, but not limited to: maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?

4. Are there large areas of intact habitat with the potential for fragmentation, with respect to species of habitat fragmentation concern needing large contiguous blocks of habitat?

Tier 1 Methods and Metrics

Developers who choose to conduct Tier 1 investigations would generally be able to utilize existing public or other readily available landscape-level maps and databases from sources such as federal, state, or tribal wildlife or natural heritage programs, the academic community, conservation organizations, or the developers' or consultants' own information. It is recommended that developers conduct a review of the publicly available data. The analysis of available sites in the region of interest will be based on a blend of the information available in published and unpublished reports, wildlife range distribution maps, and other such sources. Currently available data sources useful for this analysis are listed in Appendix C (to be developed further). The developer should check with the Service Field Office for data specific to wind energy development and wildlife at the landscape scale in Tier 1.

Use of Tier 1 Information

The objective of the Tier 1 process is to help the developer identify a site or sites to consider further for wind energy development. Possible outcomes of this internal screening process include the following:

1. One or more sites are found within the area of investigation where the answer to each of the above Tier 1 questions is "no," indicating a low probability of significant adverse impact to wildlife. The developer proceeds to Tier 2 investigations and characterization of the site or sites, answering the Tier 2 questions with site-specific data to confirm the validity of the preliminary indications of low potential for significant adverse impact.

2. A "Yes" answer to one or more of the Tier 1 questions indicates a higher probability of significant adverse impacts to wildlife. Consideration of the area may be abandoned, or effort may be devoted to identifying possible means by which the project can be modified to avoid or minimize significant adverse impacts.

3. The data available in the sources described above are insufficient to answer one or more of the Tier 1 questions. The developer proceeds to Tier 2, with a specific emphasis on

collecting the data necessary to answer the Tier 2 questions, which are inclusive of those asked at Tier 1.

Chapter 3

Tier 2 – Site Characterization

At this stage, the developer has narrowed consideration down to specific sites, and additional data may be necessary to systematically and comprehensively characterize a potential site in terms of the risk wind energy development would pose to species of concern and their habitats. In the case where a site or sites have been selected without the Tier 1 preliminary evaluation of the general ecological context, Tier 2 becomes the first stage in the site selection process. The developer will address the questions asked in Tier 1; if addressing the Tier 1 questions here, the developer will evaluate the site within a landscape context. However, a distinguishing feature of Tier 2 studies is that they focus on site-specific information and should include at least one visit to each of the prospective site(s). Because Tier 2 studies are preliminary, normally one reconnaissance level site visit will be adequate as a "ground-truth" of available information. Notwithstanding, if key issues are identified that relate to varying conditions and/or seasons, Tier 2 studies should include enough site visits during the appropriate times of the year to adequately assess these issues for the prospective site(s).

Tier 2 Questions

Questions suggested for Tier 2 can be answered using credible, publicly available information that includes published studies, technical reports, databases, and information from agencies, local conservation organizations, and/or local experts. Developers or consultants working on their behalf should contact the federal, state, tribal, and local agencies that have jurisdiction or management authority and responsibility over the potential project.

1. Are there known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?
2. Does the landscape contain areas where development is precluded by law or designated as sensitive according to scientifically credible information? Examples of designated areas include, but are not limited to: "areas of scientific importance;" "areas of significant value;" federally-designated critical habitat; high-priority conservation areas for NGOs; or other local, state, regional, federal, tribal, or international categorizations.

3. Are there plant communities of concern present or likely to be present at the site(s)?
4. Are there known critical areas of congregation of species of concern, including, but not limited to: maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?
5. Using best available scientific information has the developer or relevant federal, state, tribal, and/or local agency identified the potential presence of a population of a species of habitat fragmentation concern?
6. Which species of birds and bats, especially those known to be at risk by wind energy facilities, are likely to use the proposed site based on an assessment of site attributes?

Tier 2 Methods and Metrics

Obtaining answers to Tier 2 questions will involve a more thorough review of the existing site-specific information than in Tier 1. Tier 2 site characterizations studies will generally contain three elements:

1. A review of existing information, including existing published or available literature and databases and maps of topography, land use and land cover, potential wetlands, wildlife, habitat, and sensitive plant distribution. If agencies have documented potential habitat for species of habitat fragmentation concern, this information can help with the analysis.
2. Contact with agencies and organizations that have relevant scientific information to further help identify if there are bird, bat or other wildlife issues. It is recommended that the developer make contact with federal, state, tribal, and local agencies that have jurisdiction or management authority over the project or information about the potentially affected resources. In addition, because key NGOs and relevant local groups are often valuable sources of relevant local environmental information, it is recommended that developers contact key NGOs, even if confidentiality concerns preclude the developer from identifying specific project location information at this stage. These contacts also provide an opportunity to identify other potential issues and data not already identified by the developer.

3. One or more reconnaissance level site visits by a wildlife biologist to evaluate current vegetation/habitat coverage and land management/use. Current habitat and land use practices will be noted to help in determining the baseline against which potential impacts from the project would be evaluated. The vegetation/habitat will be used for identifying potential bird and bat resources occurring at the site and the potential presence of, or suitable habitat for, species of concern. Vegetation types or habitats will be noted and evaluated against available information such as land use/land cover mapping. Any sensitive resources located during the site visit will be noted and mapped or digital location data recorded for future reference. Any individuals or signs of species of concern observed during the site visit will be noted. If land access agreements are not in place, access to the site will be limited to public roads.

Specific resources that can help answer each Tier 2 question include:

1. **Are there known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?**

   Information review and agency contact: locations of state and federally listed, proposed and candidate species and species of concern are frequently documented in state and federal wildlife databases. Examples include published literature such as: Natural Heritage Databases, State Wildlife Action Plans, NGOs publications, and developer and consultant information, or can be obtained by contacting these entities.

   Site Visit: to the extent practicable, the site visit(s) should evaluate the suitability of habitat at the site for species identified and the likelihood of the project to adversely affect the species of concern that may be present.

2. **Does the landscape contain areas where development is precluded by law or designated as sensitive according to scientifically credible information?** Examples of designated areas include, but are not limited to: "areas of scientific importance;" "areas of significant value;" federally-designated critical habitat; high-priority conservation areas for NGOs; or other local, state, regional, federal, tribal, or international categorizations.

Information review and agency contact such as: maps of political and administrative boundaries; National Wetland Inventory data files; USGS National Land Cover data maps; state, federal and tribal agency data on areas that have been designated to preclude development, including wind energy development; State Wildlife Action Plans; State Land and Water Resource Plans; Natural Heritage databases; scientifically credible information provided by NGO and local resources; and the additional resources listed in Appendix C of this document, or through contact of agencies and NGOs, to determine the presence of high priority habitats for species of concern or conservation areas.

Site Visit: to the extent practicable, the site visit(s) should characterize and evaluate the uniqueness of the site vegetation relative to surrounding areas.

3. **Are plant communities of concern present or likely to be present at the site(s)?**

Information review and agency contact such as: Natural Heritage Data of state rankings (S1, S2, S3) or globally (G1, G2, G3) ranked rare plant communities.

Site Visit: to the extent practicable, the site visit should evaluate the topography, physiographic features and uniqueness of the site vegetation in relation to the surrounding region.

4. **Are there known critical areas of wildlife congregation, including, but not limited to, maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?**

Information review and agency contact such as: existing databases, State Wildlife Action Plan, Natural Heritage Data, and NGO and agency information regarding the presence of Important Bird Areas, migration corridors or stopovers, leks, bat hibernacula or maternity roosts, or game winter ranges at the site and in the surrounding area.

Site Visit: to the extent practicable, the site visit should evaluate the topography, physiographic features and uniqueness of the site in relation to the surrounding region to assess the potential for the project area to concentrate resident or migratory birds and bats.

5. **Using best available scientific information, has the developer or relevant federal, state, tribal, and/or local agency independently identified the potential presence of a**

population of a species of habitat fragmentation concern? If not, the developer need not assess impacts of the proposed project on habitat fragmentation.

Habitat fragmentation is defined as the separation of a block of habitat for a species into segments, such that the genetic or demographic viability of the populations surviving in the remaining habitat segments is reduced; and risk, in this case, is defined as the probability that this fragmentation will occur as a result of the project. Site clearing, access roads, transmission lines and turbine tower arrays remove habitat and displace some species of wildlife, and may fragment continuous habitat areas into smaller, isolated tracts. Habitat fragmentation is of particular concern when species require large expanses of habitat for activities such as breeding and foraging.

Consequences of isolating local populations of some species include decreased reproductive success, reduced genetic diversity, and increased susceptibility to chance events (e.g. disease and natural disasters), which may lead to extirpation or local extinctions. In addition to displacement, development of wind energy infrastructure may result in additional loss of habitat for some species due to "edge effects" resulting from the break-up of continuous stands of similar vegetation resulting in an interface (edge) between two or more types of vegetation. The extent of edge effects will vary by species and may result in adverse impacts from such effects as a greater susceptibility to colonization by invasive species, increased risk of predation, and competing species favoring landscapes with a mosaic of vegetation.

If the answer to Tier 2 Question 5 is yes, it is recommended the developer use the general framework for evaluating habitat fragmentation at a project site in Tier 2 outlined below. Developers and the Service may use this method to analyze the impacts of habitat fragmentation at wind development project sites on species of habitat fragmentation concern. Service field offices can provide the available information on habitat types, quality and intactness. Developers may use this information in combination with site-specific information on the potential habitats to be impacted by a potential development and how they will be impacted.

General Framework for Evaluating Habitat Fragmentation at a Project Site (Tier 2)

A. The developer should define the study area. The study area should include the Project Site (see Glossary) for the proposed project. The extent of the study area should be based on the distribution of habitat for the local population of the species of habitat fragmentation concern.

B. The developer should analyze the current habitat quality and spatial configuration of the study area for the species of habitat fragmentation concern.

i. Use recent aerial and remote imagery to determine distinct habitat patches, or boundaries, within the study area, and the extent of existing habitat fragmenting features (e.g., highways).

ii. Assess the level of fragmentation of the existing habitat for the species of habitat fragmentation concern and categorize into three classes:

- High quality: little or no apparent fragmentation of intact habitat
- Medium quality: intact habitat exhibiting some recent disturbance activity (e.g., off-road vehicle (ORV) trails, roadways)
- Low quality: Extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)

C. The developer should determine potential changes in quality and spatial configuration of the habitat in the study area if development were to proceed as proposed using existing site information.

D. The developer should provide the collective information from steps A-C for all potential developments to the Service for use in assessing whether the habitat impacts, including habitat fragmentation, are likely to affect population viability of the potentially affected species of habitat fragmentation concern.

6. Which species of birds and bats, especially those known to be at risk by wind energy facilities, are likely to use the proposed site based on an assessment of site attributes?

Information review and agency contact: existing published information and databases from NGOs and federal and state resource agencies regarding the potential presence of:

- Raptors: species potentially present by season
- Prairie grouse and sage grouse: species potentially present by season and location of known leks
- Other birds: species potentially present by season that may be at risk of collision or adverse impacts to habitat, including loss, displacement and fragmentation
- Bats: species likely to be impacted by wind energy facilities and likely to occur on or migrate through the site

Site Visit: To the extent practicable, the site visit(s) should identify landscape features or habitats that could be important to raptors, prairie grouse, other birds that may be at risk of adverse impacts, and bats, including nesting and brood-rearing habitats, areas of high prey density, movement corridors and features such as ridges that may concentrate raptors. Raptors, prairie grouse, and other presence or sign of species of concern seen during the site visit should be noted, with species identification if possible.

Tier 2 Decision Process

Possible outcomes of Tier 2 include the following:

1. If the results of the site assessment indicate that one or more species of concern are present, a developer should consider applicable regulatory or other agency processes for addressing them. For instance, if migratory birds and bats are present and likely to be affected by a wind project located there, a developer should consider preparing an Avian and Bat Protection Plan (ABPP). If bald or golden eagles are present and likely to be affected by a wind project located there, a developer should prepare an ECP and, if necessary, apply for a programmatic take permit. If endangered or threatened species are present and likely to be affected by a wind project located there, a federal agency should consult with the Service under Section 7(a)(2) of the ESA if the project has a federal nexus or the developer should apply for a section 10(a)(1)(B) incidental take permit if

there is not a federal nexus, but incidental take of listed wildlife is anticipated. State, tribal, and local jurisdictions may have additional permitting requirements.

2. The most likely outcome of Tier 2 is that the answer to one or more Tier 2 questions is inconclusive to address wildlife risk, either due to insufficient data to answer the question or because of uncertainty about what the answers indicate (for example, Tier 2 site characterization may capture the presence of features indicating wildlife congregation, but may not capture seasonality and spatial variation of wildlife use). The developer proceeds to Tier 3, formulating questions, methods, and assessment of potential mitigation measures based on issues raised in Tier 2 results.
3. Sufficient information is available to answer all Tier 2 questions, and the answer to each Tier 2 question indicates a low probability of significant adverse impact to wildlife (for example, infill or expansion of an existing facility where impacts have been low and Tier 2 results indicate that conditions are similar, therefore wildlife risk is low). The developer may then decide to proceed to obtain state and local permit (if required), design, and construction following best management practices (see Chapter 7).
4. The answers to one or more Tier 2 questions indicate a high probability of significant adverse impacts to species of concern or their habitats that cannot be adequately mitigated. The proposed site should be abandoned.

Chapter 4

Tier 3 – Field Studies to Document Site Wildlife Conditions and Predict Project Impacts

Tier 3 is the first tier in which quantitative and scientifically rigorous studies would be conducted to assess the potential risk of the proposed project. Specifically, these studies provide pre-construction information to:

- Further evaluate a site for determining whether the wind energy project should be developed or abandoned
- Design and operate a site to avoid or minimize significant adverse impacts if a decision is made to develop
- Design compensatory mitigation measures if significant adverse habitat impacts cannot acceptably be avoided or minimized
- Determine duration and level of effort of post-construction monitoring. If warranted, provide the pre-construction component of Tier 5 studies necessary to estimate impacts

At the beginning of Tier 3, a developer should communicate with the Service on the pre-construction studies. At the end of Tier 3, developers should coordinate with the Service to complete the Tier 3 decision process. The Service will provide written comments to a developer on study and project development plans that identify concerns and recommendations to resolve the concerns.

Not all Tier 3 studies will continue into Tiers 4 or 5. For example, surveys conducted in Tier 3 for species of concern may indicate one or more species are not present at the proposed project site, or siting decisions could be made in Tier 3 that remove identified concerns, thus removing the need for continued efforts in later tiers. Additional detail on the design of Tier 5 studies that begin in Tier 3 is provided in the discussion of methods and metrics in Tier 5.

Tier 3 Questions

Tier 3 begins as the other tiers begin, with problem formulation: what additional studies are required to enable a decision as to whether the proposed project can proceed to construction or operation or should be abandoned? This step includes an evaluation of data gaps identified by Tier 2 studies as well as the gathering of data necessary to:

- Design a project to avoid or minimize predicted risk
- Evaluate predictions of impact and risk through post-construction comparisons of estimated impacts (i.e., Tier 4 monitoring and 5 studies)
- Identify compensatory mitigation measures, if appropriate, to offset unavoidable significant adverse impacts

The problem formulation stage for Tier 3 also will include an assessment of which species identified in Tier 1 and/or Tier 2 will be studied further in the site risk assessment. This determination is based on analysis of existing data from Tier 1 and existing site-specific data and Project Site (see Glossary) visit(s) in Tier 2, and on the likelihood of presence and the degree of adverse impact to species or their habitat. If the habitat is suitable for a species needing further study and the site occurs within the historical range of the species, or is near the existing range of the species but presence has not been documented, additional field studies may be appropriate. Additional analyses should not be necessary if a species is unlikely to be present or is present but adverse impact is unlikely or of minor significance.

Tier 3 studies address many of the questions identified for Tiers 1 and 2, but Tier 3 studies differ because they attempt to quantify the distribution, relative abundance, behavior, and site use of species of concern. Tier 3 data also attempt to estimate the extent that these factors expose these species to risk from the proposed wind energy facility. Therefore, in answering Tier 3 questions 1-3, developers should collect data sufficient to analyze and answer Tier 3 questions 4-6.

If Tier 3 studies identify species of concern or important habitats, e.g., wetlands, which have specific regulatory processes and requirements, developers should work with appropriate state, tribal, or federal agencies to obtain required authorizations or permits.

Tier 3 studies should be designed to answer the following questions:

Comment [UF&WS1]: Note to FAC: Tier 3 questions do not ask a developer to predict fatality rates. Yet Tier 4 specifically calls for a comparison between predicted fatality rates in Tiers 2 and 3 and actual fatality rates as determined in Tier 4.

How does the FAC recommend the Service address this?

1. Do field studies indicate that species of concern are present on or likely to use the proposed site?
2. Do field studies indicate the potential for significant adverse impacts on the affected population of the species of habitat fragmentation concern?
3. What is the distribution, relative abundance, behavior, and site use of species of concern identified in Tiers 1 or 2, and to what extent do these factors expose these species to risk from the proposed project?
4. What are the potential risks of adverse impacts of the proposed project to individuals and local populations of species of concern or their habitats?
5. If significant adverse impacts are predicted to species of concern, can these impacts be avoid and/or mitigated?
6. Are there studies that should be initiated at this stage that would be continued in either Tier 4 or Tier 5?

Tier 3 Methods and Metrics[2]

The Service encourages the use of common methods and metrics in Tier 3 assessments for measuring wildlife activity and habitat features. Common methods and metrics provide great benefit over the long-term, allowing for comparisons among projects and for greater certainty regarding what will be asked of the developer for a specific project. Deviation from commonly used methods should be carefully considered, scientifically justifiable and discussed with federal, tribal, or state natural resource agencies, or other credible experts, as appropriate. It may be

[2] The references cited herein were provided by the Wind Turbine Guidelines Advisory Committee. Additional information is available in Appendix C.

useful to consult other scientifically credible information sources. A list of references citing common methods and metrics is provided in Appendix C, including the National Wind Coordinating Collaborative's Studying Wind Energy/Wildlife Interactions: A Guidance Document (2011).

Tier 3 studies will be designed to accommodate local and regional characteristics. The specific protocols by which common methods and metrics are implemented in Tier 3 studies depend on the question being addressed, the species or ecological communities being studied and the characteristics of the study sites. Federally-listed threatened and endangered species, eagles, and some other species of concern and their habitats, may have specific protocols required by local, state or federal agencies. The need for special surveys and mapping that address these species and situations should be discussed with the appropriate stakeholders.

In some instances, a single method will not adequately assess potential collision risk or habitat impact. For example, when there is concern about moderate or high risk to nocturnally active species, such as migrating passerines and local and migrating bats, a combination of remote sensing tools such as radar, and acoustic monitoring for bats and indirect inference from diurnal bird surveys during the migration period may be necessary. Answering questions about habitat use by songbirds may be accomplished by relatively small-scale observational studies, while answering the same question related to wide-ranging species such as prairie grouse and sage grouse may require more time-consuming surveys, perhaps including telemetry.

Because of the points raised above and the need for flexibility in application, the Guidelines do not make specific recommendations on protocol elements for Tier 3 studies. The peer-reviewed scientific literature (such as the articles cited throughout this section) contains numerous recently published reviews of methods for assessing bird and bat activity, and tools for assessing habitat and landscape level risk. Details on specific methods and protocols for recommended studies are or will be widely available and should be consulted by industry and agency professionals.

Many methods for assessing risk are components of active research involving collaborative efforts of public-private research partnerships with federal, state and tribal agencies, wind energy developers and NGOs interested in wind energy-wildlife interactions (e.g., Bats and Wind Energy Cooperative and the Grassland Shrub Steppe Species Cooperative). It is important to recognize the need to integrate the results of research that improves existing methods or describes new methodological developments, while acknowledging the value of utilizing common methods that are currently available.

The remainder of this section outlines the methods and metrics that may be appropriate for gathering data to answer Tier 3 questions. These are not meant to be all inclusive and other methods and metrics are available, such as the NWCC Methods & Metrics document (in press).

Elements to Consider When Determining What to Study

Several factors can be considered to assess the potential effects to various species. Not all of these may be considered at all locations. First, the potential for presence of the species in the project area during the life of the project should be considered. Assessing species use from databases and site characteristics is a potential first step; however, it can be difficult to assess potential use by certain species from site characteristics alone. Various species in different locations may require developers to use specific survey protocols or make certain assumptions regarding presence. Seek local wildlife expertise, such as Service Field Office staff, in using the proper procedures and making assumptions.

Species that are rare or cryptic; that migrate, conduct other daily movements, or use areas for short periods of time; that are small in size or nocturnal; or that have become extirpated in parts of their historical range will present particular challenges when trying to determine potential presence. One of these challenges is "migration," broadly defined as the act of moving from one spatial unit to another (Baker 1978), or as a periodic movement of animals from one location to another. Migration is species-specific, and for birds and bats occurs throughout the year. Such movements should be considered for all potentially affected species, including flying insects and species that migrate on the ground.

Developers should conduct monitoring of potential sites to determine the types of migratory species present, what type of spatial and temporal use these species make of the site (e.g., chronology of migration or other use), and the ecological function the site may provide in terms of the migration cycle of these species. Wind developers need to determine not only what species may migrate through a proposed development site and when, but also whether a site may function as a staging area or stopover habitat for wildlife on their migration pathway.

For some species, movements between foraging and breeding habitat, or between sheltering and feeding habitats, occur on a daily basis. Consideration of daily movements (morning and evening; coming and going) is a critical factor when considering project development.

Once likely presence has been determined or assumed, determine level of exposure regarding various risk factors, including abundance, frequency of use, habitat use patterns, and behavior. Finally, consider and/or determine the consequences to the "populations" and species.
Below is a brief discussion of several types of risk factors that can be considered. This does not include all potential risk factors for all species, but addresses the most common ones.

a. Collision and Barotrauma

Collision likelihood for individual birds and bats at a particular wind energy facility may be the result of complex interactions among species distribution, "relative abundance," behavior, visibility, weather conditions, and site characteristics. Collision likelihood for an individual may be low regardless of abundance if its behavior does not place it within the "rotor-swept zone." Individuals that frequently occupy the rotor-swept zone but effectively avoid collisions are also at low likelihood of collision with a turbine.

Alternatively, if the behavior of individuals frequently places them in the rotor-swept zone, and they do not actively avoid turbine blade strikes, they are at higher likelihood of collisions with turbines regardless of abundance. Some species, even at lower abundance, may have a higher collision rate than similar species due to subtle differences in their ecology and behavior.
At many projects, the numbers of bat fatalities are higher than the numbers of bird fatalities, but the exposure risk of bats at these facilities is not fully understood. Researchers (Horn et al. 2008 and Cryan 2008) hypothesize that some bats may be attracted to turbines, which, if true, would further complicate estimation of exposure. Further research is required to determine whether

bats are attracted to turbines and if so, whether this increased individual risk translates into higher population-scale effects.

b. Habitat Loss and Degradation

Wind project development results in direct habitat loss and habitat modification, especially at sites previously undeveloped. Many of North America's native landscapes are greatly diminished or degraded from multiple causes unrelated to wind energy. Important remnants of these landscapes are identified and documented in various databases held by private conservation organizations, state wildlife agencies, and, in some cases, by the Service. Species that depend on these landscapes are susceptible to further loss of habitat, which will affect their ability to reproduce and survive. While habitat lost due to footprints of turbines, roads, and other infrastructure is obvious, less obvious is the potential reduction of habitat quality.

c. Habitat Fragmentation

Habitat fragmentation separates blocks of habitat for some species into segments, such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area. Site clearing, access roads, transmission lines, and arrays of turbine towers may displace some species or fragment continuous habitat areas into smaller, isolated tracts. Habitat fragmentation is of particular concern when species require large expanses of habitat for activities such as breeding, foraging, and sheltering.

Habitat fragmentation can result in increases in "edge" resulting in direct effects of barriers and displacement as well as indirect effects of nest parasitism and predation. Sensitivity to fragmentation effects varies among species. Habitat fragmentation and site modification are important issues that should be assessed at the landscape scale early in the siting process. Identify areas of high sensitivity due to the presence of blocks of native habitats, paying particular attention to known or suspected "species sensitive to habitat fragmentation."

d. Displacement and Behavioral Changes

Estimating displacement risk requires an understanding of animal behavior in response to a project and its infrastructure and activities, and a pre-construction estimate of presence/absence of species whose behavior would cause them to avoid or seek areas in proximity to turbines, roads, and other components of the project. Displacement is a function of the sensitivity of individuals to the project and activity levels associated with operations.

e. Indirect Effects

Wind development can also have indirect effects to wildlife and habitats. Indirect effects include reduced nesting and breeding densities and the social ramifications of those reductions; loss or modification of foraging habitat; loss of population vigor and overall population density; increased isolation between habitat patches, loss of habitat refugia; attraction to modified habitats; effects on behavior, physiological disturbance, and habitat unsuitability. Indirect effects can result from introduction of invasive plants; increased predator populations or facilitated predation; alterations in the natural fire regime; or other effects, and can manifest themselves later in time than the causing action.

Each question is considered in turn, followed by a discussion of the methods and their applicability.

1. Do field studies indicate that species of concern are present on or likely to use the proposed site?

In many situations, this question can be answered based on information accumulated in Tier 2. Specific presence/absence studies may not be required, and protocol development will focus on answering the remaining Tier 3 questions. Nevertheless, it may be necessary to conduct field studies to determine the presence, or likelihood of presence, when little information is available for a particular site. The level of effort normally contemplated for Tier 3 studies should detect common species and species that are relatively rare, but which visit a site regularly (e.g., every year). In the event a species of concern is very rare and only occasionally visits a site, a determination of "likely to occur" would be inferred from the habitat at the site and historical records of occurrence on or near the site.

State, federal and tribal agencies often require specific protocols be followed when species of concern are potentially present on a site. The methods and protocols for determining presence of species of concern at a site are normally established for each species and required by federal, state and tribal resource agencies. Surveys should sample the wind turbine sites and applicable disturbance area during seasons when species are most likely present. Normally, the methods and protocols by which they are applied also will include an estimate of relative abundance. Most presence/absence surveys should be done following a probabilistic sampling protocol to allow statistical extrapolation to the area and time of interest.

Acoustic monitoring can be a practical method for determining the presence of threatened, endangered or otherwise rare species of bats throughout a proposed project (Kunz et al. 2007). There are two general types of acoustic detectors used for collection of information on bat activity and species identification: the full-spectrum, time-expansion and the zero-crossing techniques for ultrasound bat detection (see Kunz et al. 2007 for detailed discussion). Full-spectrum time expansion detectors provide nearly complete species discrimination, while zero-crossing detectors provide reliable and cost-effective estimates of total bat use at a site and some species discrimination. *Myotis* species can be especially difficult to discriminate with zero-crossing detectors (Kunz et al. 2007). Kunz et al. (2007) describe the strengths and weaknesses of each technique for ultrasonic bat detection, and either type of detector may be useful in most situations except where species identification is especially important and zero-crossing methods are inadequate to provide the necessary data. Bat acoustics technology is evolving rapidly and study objectives are an important consideration when selecting detectors. When rare or endangered species of bats are suspected, sampling should occur during different seasons and at multiple sampling stations to account for temporal and spatial variability.

Mist-netting for bats is required in some situations by state agencies, Tribes, and the Service to determine the presence of threatened, endangered or otherwise rare species. Mist-netting is best used in combination with acoustic monitoring to inventory the species of bats present at a site, especially to detect the presence of threatened or endangered species. Efforts should concentrate on potential commuting, foraging, drinking, and roosting sites (Kuenzi and Morrison 1998, O'Farrell et al. 1999). Mist-netting and other activities that involve capturing and handling threatened or endangered species of bats will require permits from state and/or federal agencies.

Determining the presence of diurnally or nocturnally active mammals, reptiles, amphibians, and other species of concern will typically be accomplished by following agency-required protocols. Most listed species have required protocols for detection (e.g., the black-footed ferret). State, tribal and federal agencies should be contacted regarding survey protocols for those species of concern. See Corn and Bury 1990, Olson et al. 1997, Bailey et al. 2004, Graeter et al. 2008 for examples of reptile and amphibian protocols, survey and analytical methods.

2. Do field studies indicate significant adverse impacts on species of habitat fragmentation concern?

If the answer to Tier 2 Question 5 was yes, but existing information did not allow for a complete analysis of potential impacts and decision-making, then additional studies and analyses should take place in Tier 3.

As in Tier 2, the particulars of the analysis will depend on the species of habitat fragmentation concern and how habitat block size and fragmentation are defined for the life cycles of that species, the likelihood that the project will adversely affect a local population of the species and the significance of these impacts to the viability of that population.

To assess habitat fragmentation in the project vicinity, developers should evaluate landscape characteristics of the proposed site prior to construction and determine the degree to which habitat for species of habitat fragmentation concern will be significantly altered by the presence of a wind energy facility.

A general framework for evaluating habitat fragmentation at a project site, following that described in Tier 2, is outlined below. This framework should be used in those circumstances when the developer, or a relevant federal, state, tribal and/or other local agency demonstrates the potential presence of a population of a species of habitat fragmentation concern that may be adversely affected by the project. Otherwise, the developer need not assess the impacts of the proposed project on habitat fragmentation. This method for analysis of habitat fragmentation at project sites must be adapted to the local population of the species of habitat fragmentation concern potentially affected by the proposed development.

The developer should:

1. Define the study area. The study area for the site should include the "footprint" for the proposed facility plus an appropriate surrounding area. The extent of the study area should be based on the area where there is potential for significant adverse habitat impacts, including displacement, within the distribution of habitat for the species of habitat fragmentation concern.

2. Determine the potential for occupancy of the study area based on the guidance provided for the species of habitat fragmentation concern described above in Question 1.

3. Analyze current habitat quality and spatial configuration of the study area for the species of habitat fragmentation concern.
    a. Use recent aerial or remote imagery to determine distinct habitat patches or boundaries within the study area, and the extent of existing habitat fragmenting features.
        i. Assess the level of fragmentation of the existing habitat for the species of habitat fragmentation concern and categorize into three classes:
            - High quality: little or no apparent fragmentation of intact habitat
            - Medium quality: intact habitat exhibiting some recent disturbance activity (e.g., timber clearing, ORV trails, roadways)
            - Low quality: extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)

ii. Determine edge and interior habitat metrics of the study area:
- Identify habitat, non-habitat landscape features and existing fragmenting features relative to the species of habitat fragmentation concern, to estimate existing edge
- Calculate area and acres of edge
- Calculate area of intact patches of habitat and compare to needs of species of habitat fragmentation concern

b. Determine potential changes in quality and spatial configuration of the habitat in the study area if development proceeds as proposed using existing site information and the best available spatial data regarding placement of wind turbines and ancillary infrastructure:

i. Identify, delineate and classify all additional features added by the development that potentially fragment habitat for the species of habitat fragmentation concern (e.g., roads, transmission lines, maintenance structures, etc.)

ii. Assess the expected future size and quality of habitat patches for the species of habitat fragmentation concern and the additional fragmenting features, and categorize into three classes as described above

iii. Determine expected future acreages of edge and interior habitats

iv. Calculate the area of the remaining patches of intact habitat

c. Compare pre-construction and expected post-construction fragmentation metrics:

i. Determine the area of intact habitat lost (to the displacement footprint or by alteration due to the edge effect)

ii. Identify habitat patches that are expected to be moved to a lower habitat quality classification as a result of the development

4. Assess the likelihood of a significant reduction in the demographic and genetic viability of the local population of the species of habitat fragmentation concern using the habitat

fragmentation information collected under item 3 above and any currently available demographic and genetic data. Based on this assessment, the developer makes the finding whether or not there is significant reduction. The developer should share the finding with the relevant agencies. If the developer finds the likelihood of a significant reduction, the developer should consider items a, b or c below:

a. Consider alternative locations and development configurations to minimize fragmentation of habitat in communication with species experts, for all species of habitat fragmentation concern in the area of interest.

b. Identify high quality habitat parcels that may be protected as part of a plan to limit future loss of habitat for the impacted population of the species of habitat fragmentation concern in the area.

c. Identify areas of medium or low quality habitat within the range of the impacted population that may be restored or improved to compensate for losses of habitat that result from the project (e.g., management of unpaved roads and ORV trails).

This protocol for analysis of habitat fragmentation at project sites should be adapted to the species of habitat fragmentation concern as identified in response to Question 5 in Tier 2 and to the landscape in which development is contemplated.

3. What is the distribution, relative abundance, behavior, and site use of species of concern identified in Tiers 1 or 2, and to what extent do these factors expose these species to risk from the proposed wind energy project?

For those species of concern that are considered at risk of collisions or habitat impacts, the questions to be answered in Tier 3 include: where are they likely to occur (i.e., where is their habitat) within a project site or vicinity, when might they occur, and in what abundance. The spatial distribution of species at risk of collision can influence how a site is developed. This distribution should include the airspace for flying species with respect to the rotor-swept zone.

The abundance of a species and the spatial distribution of its habitat can be used to determine the relative risk of impact to species using the sites, and the absolute risk when compared to existing projects where similar information exists. Species abundance and habitat distribution can also be used in modeling risk factors.

Surveys for spatial distribution and relative abundance require coverage of the wind turbine sites and applicable site disturbance area, or a sample of the area using observational methods for the species of concern during the seasons of interest. As with presence/absence (see Tier 3, question 1, above) the methods used to determine distribution, abundance, and behavior may vary with the species and its ecology. Spatial distribution is determined by applying presence/absence or using surveys in a probabilistic manner over the entire area of interest.

Bird distribution, abundance, behavior and site use

Diurnal Avian Activity Surveys

The commonly used data collection methods for estimating the spatial distribution and relative abundance of diurnal birds includes counts of birds seen or heard at specific survey points (point count) or along transects (transect surveys). Both methods result in estimates of bird use, which are assumed to be indices of abundance in the area surveyed. Absolute abundance is difficult to determine for most species and is not necessary to evaluate species risk. Surveys for raptor and other large bird use should be done using point counts. Depending on the characteristics of the area of interest and the bird species potentially affected by the project, additional pre-construction study methods may be necessary. Point counts or line transects should collect vertical as well as horizontal data to identify levels of activity within the rotor-swept zone.

Avian point counts should follow the general methodology described by Reynolds et al. (1980) for point counts within a fixed area, or the line transect survey similar to Schaffer and Johnson (2008), where all birds seen within a fixed distance of a line are counted. These methods are most useful for pre- and post-construction studies to quantify avian use of the project site by habitat, determine the presence of species of concern, and to provide a baseline for assessing displacement effects and habitat loss. Point counts for large birds (e.g., raptors) follow the same point count method described by Reynolds et al. (1980).

Point count plots or transects should allow for statistical extrapolation of data and be distributed throughout the area of interest using a probability sampling approach (e.g., systematic sample with a random start). For most projects, the area of interest is the area where wind turbines and permanent meteorological (met) towers are proposed or expected to be sited. Alternatively, the centers of the larger plots can be located at vantage points throughout the potential area being considered with the objective of covering most of the area of interest. Flight height should also be collected to focus estimates of use on activity occurring in the rotor-swept zone.

Sampling duration and frequency will be determined on a project-by-project basis and by the questions being addressed. The most important consideration for sampling frequency when estimating abundance is the amount of variation expected among survey dates and locations and the species of concern.

The use of comparable methods and metrics should allow data comparison from plot to plot within the area of interest and from site to site where similar data exist. The data should be collected so that avian activity can be estimated within the rotor-swept zone. Relating use to site characteristics requires that samples of use also measure site characteristics thought to influence use (i.e., covariates such as vegetation and topography) in relation to the location of use. The statistical relationship of use to these covariates can be used to predict occurrence in unsurveyed areas during the survey period and for the same areas in the future.

Surveys should be conducted at different intervals during the year to account for variation in expected bird activity with lower frequency during winter months if avian activity is low. Sampling frequency should also consider the episodic nature of activity during fall and spring migration. Standardized protocols for estimating avian abundance are well-established and should be consulted (e.g., Dettmers et al. 1999). If a more precise estimate of density is required for a particular species (e.g., when the goal is to determine densities of a special-status breeding bird species), the researcher will need more sophisticated sampling procedures, including estimates of detection probability.

Raptor Nest Searches

An estimate of raptor use of the project site is obtained through the point counts, but if potential impacts to breeding raptors are a concern on a project, raptor nest searches are also recommended. These surveys provide information to predict risk to the local breeding population of raptors, for micro-siting decisions, and for developing an appropriate-sized non-disturbance buffer around nests. Surveys also provide baseline data for estimating impacts and determining mitigation requirements.

Searches for raptor nests or raptor breeding territories on projects with potential for impacts to raptors should be conducted in suitable habitat during the breeding season. While there is no consensus on the recommended buffer zones around nest sites to avoid disturbance of most species (Sutter and Jones 1981), a nest search within at least one mile of the wind turbines and transmission lines should be conducted. However, larger nest search areas are needed for eagles, as explained in the Service's ECP Guidance.

Methods for these surveys are fairly common and will vary with the species, terrain, and vegetation within the survey area. It is recommended that draft protocols be discussed with biologists from the lead agency, Service, state wildlife agency, and Tribes where they have jurisdiction. It may be useful to consult other scientifically credible information sources. At minimum, the protocols should contain the list of target raptor species for nest surveys and the appropriate search protocol for each site, including timing and number of surveys needed, search area, and search techniques.

Prairie Grouse and Sage Grouse Population Assessments

Sage grouse and prairie grouse merit special attention in this context for three reasons:

1. The scale and biotic nature of their habitat requirements uniquely position them as reliable indicators of impacts on, and needs of, a suite of species that depend on sage and

grassland habitats, which are among the nation's most diminished ecological communities (Vodehnal and Haufler 2007).

2. Their ranges and habitats are highly congruent with the nation's richest inland wind resources.
3. They are species for which some known impacts of anthropogenic features (e.g., tall structures, buildings, roads, transmission lines, wind energy facilities, etc.) have been documented.

Populations of prairie grouse and sage grouse generally are assessed by either lek counts (a count of the maximum number of males attending a lek) or lek surveys (classification of known leks as active or inactive) during the breeding season (e.g., Connelly et al. 2000). Methods for lek counts vary slightly by species but in general require repeated visits to known sites and a systematic search of all suitable habitat for leks, followed by repeated visits to active leks to estimate the number of grouse using them.

Recent research indicates that viable prairie grouse and sage grouse populations are dependent on suitable nesting and brood-rearing habitat (Connelly et al. 2000, Hagen et al. 2009). These habitats generally are associated with leks. Leks are the approximate centers of nesting and brood-rearing habitats (Connelly et al. 2000, but see Connelly et al. 1988; Becker et al. 2009,). High quality nesting and brood rearing habitats surrounding leks are critical to sustaining viable prairie grouse and sage grouse populations (Giesen and Connelly 1993, Hagen et al. 2004, Connelly et al. 2000). A population assessment study area should include nesting and brood rearing habitats that may extend several miles from leks. For example, greater and lesser prairie-chickens generally nest in suitable habitats within one to two miles of active leks (Hagen et al. 2004), whereas the average distances from nests to active leks of non-migratory sage grouse range from 0.7 to four miles (Connelly et al. 2000), and potentially much more for migratory populations (Connelly et al. 1988).

While surveying leks during the spring breeding season is the most common and convenient tool for monitoring population trends of prairie grouse and sage grouse, documenting available nesting and brood rearing habitat within and adjacent to the potentially affected area is recommended. Suitable nesting and brood rearing habitats can be mapped based on habitat requirements of individual species. The distribution and abundance of nesting and brood rearing habitats can be used to help in the assessment of adverse impacts of the proposed project to prairie grouse and sage grouse.

Mist-Netting for Birds

Mist-netting is not recommended as a method for assessing risk of wind development for birds. Mist-netting cannot generally be used to develop indices of relative bird abundance, nor does it provide an estimate of collision risk as mist-netting is not feasible at the heights of the rotor-swept zone and captures below that zone may not adequately reflect risk. Operating mist-nets requires considerable experience, as well as state and federal permits.

Occasionally mist-netting can help confirm the presence of rare species at documented fallout or migrant stopover sites near a proposed project. If mist-netting is to be used, it is recommended that procedures for operating nets and collecting data be followed in accordance with Ralph et al. (1993).

Nocturnal Bird Survey Methods

Additional studies using different methods will be required if characteristics of the project site and surrounding areas potentially pose a high risk of collision to night migrating songbirds and other nocturnally active species. For most of their flight, songbirds and other nocturnal migrants are above the reach of wind turbines, but they pass through the altitudinal range of wind turbines during ascents and descents and may also fly closer to the ground during inclement weather (Able, 1970; Richardson, 2000). Factors affecting flight path, behavior, and “fall-out” locations of nocturnal migrants are reviewed elsewhere (e.g., Williams et al., 2001; Gauthreaux and Belser, 2003; Richardson, 2000; Mabee et al., 2006).

In general, pre-construction nocturnal studies are not recommended unless the site has features that might strongly concentrate nocturnal birds, such as along coastlines that are known to be migratory songbird corridors. Biologists knowledgeable about nocturnal bird migration and familiar with patterns of migratory stopovers in the region should assess the potential risks to nocturnal migrants at a proposed project site. No single method can adequately assess the spatial and temporal variation in nocturnal bird populations or the potential collision risk. Following nocturnal study methods in Kunz et al. (2007) is recommended to determine relative abundance, flight direction and flight altitude for assessing risk to migrating birds, if warranted. If areas of interest are within the range of nocturnal species of concern (e.g., marbled murrelet, northern spotted owl, Hawaiian petrel, Newell's shearwater), surveyors should use species-specific protocols recommended by state wildlife agencies, Tribes or Service to assess the species' potential presence in the area of interest.

In contrast to the diurnal avian survey techniques previously described, considerable variation and uncertainty exist on the optimal protocols for using acoustic monitoring devices, radar, and other techniques to evaluate species composition, relative abundance, flight height, and trajectory of nocturnal migrating birds. While an active area of research, the use of radar for determining passage rates, flight heights and flight directions of nocturnal migrating animals has yet to be shown as a good indicator of collision risk. Pre- and post-construction studies comparing radar monitoring results to estimates of bird and bat fatalities will be required to evaluate radar as a tool for predicting collision risk. Additional studies are also needed before making recommendations on the number of nights per season or the number of hours per night that are appropriate for radar studies of nocturnal bird migration (Mabee et al., 2006).

<u>*Bat survey methods*</u>

It is recommended that all techniques discussed below be conducted by biologists trained in bat identification, equipment use, and the analysis and interpretation of data resulting from the design and conduct of the studies. Activities that involve capturing and handling bats may require permits from state and/or federal agencies.

Acoustic Monitoring

Acoustic monitoring provides information about bat presence and activity, as well as seasonal changes in species occurrence and use, but does not measure the number of individual bats or population density. The goal of acoustic monitoring is to provide a prediction of the potential risk of bat fatalities resulting from the construction and operation of a project. Our current state of knowledge about bat-wind turbine interactions, however, does not allow a quantitative link between pre-construction acoustic assessments of bat activity and operations fatalities. Discussions with experts, state wildlife trustee agencies, Tribes, and Service will be needed to determine whether acoustic monitoring is warranted at a proposed project site.

The predominance of bat fatalities detected to date are migratory species and acoustic monitoring should adequately cover periods of migration and periods of known high activity for other (i.e., non-migratory) species. Monitoring for a full year is recommended in areas where there is year round bat activity. Data on environmental variables such as temperature and wind speed should be collected concurrently with acoustic monitoring so these weather data can be used in the analysis of bat activity levels.

The number and distribution of sampling stations necessary to adequately estimate bat activity have not been well established but will depend, at least in part, on the size of the project area, variability within the project area, and a Tier 2 assessment of potential bat occurrence.

The number of detectors needed to achieve the desired level of precision will vary depending on the within-site variation (e.g., Arnett et al. 2006, Weller 2007, E.B. Arnett, Bat Conservation International, unpublished data). One frequently used method is to place acoustic detectors on existing met towers, approximately every two kilometers across the site where turbines are expected to be sited. Acoustic detectors should be placed at high positions (as high as practicable, based on tower height) on each met tower included in the sample to record bat activity at or near the rotor swept zone, the area of presumed greatest risk for bats. Developers should evaluate whether it would be cost effective to install detectors when met towers are first established on a site. Doing so might reduce the cost of installation later and might alleviate time delays to conduct such studies.

If sampling at met towers does not adequately cover the study area or provide sufficient replication, additional sampling stations can be established at low positions (~1.5-2 meters) at a sample of existing met towers and one or more mobile units (i.e., units that are moved to different locations throughout the study period) to increase coverage of the proposed project area. When practical and based on information from Tier 2, it may be appropriate to conduct some acoustic monitoring of features identified as potentially high bat use areas within the study area (e.g., bat roosts and caves) to determine use of such features.

There is growing interest in determining whether "low" position samples (~1.5-2 meters) can provide equal or greater correlation with bat fatalities than "high" position samples (described above) because this would substantially lower cost of this work. Developers could then install a greater number of detectors at lower cost resulting in improved estimates of bat activity and, potentially, improved qualitative estimates of risk to bats. This is a research question that is not expected to be addressed at a project.

Other bat survey techniques

Occasionally, other techniques may be needed to answer Tier 3 questions and complement the information from acoustic surveys. Kunz et al. (2007), NAS (2007), Kunz and Parsons (2009) provide comprehensive descriptions of bat survey techniques, including those identified below that are relevant for Tier 3 studies at wind energy facilities.

Roost Searches and Exit Counts

Pre-construction survey efforts may be recommended to determine whether known or likely bat roosts in mines, caves, bridges, buildings, or other potential roost sites occur within the project vicinity, and to confirm whether known or likely bat roosts are present and occupied by bats. If active roosts are detected, it may be appropriate to address questions about colony size and species composition of roosts. Exit counts and roost searches are two approaches to answering these questions, and Rainey (1995), Kunz and Parsons (2009), and Sherwin et al. (2009) are resources that describe options and approaches for these techniques. Roost searches should be performed cautiously because roosting bats are sensitive to human disturbance (Kunz et al. 1996). Known maternity and hibernation roosts should not be entered or otherwise disturbed unless authorized by state and/or federal wildlife agencies. Internal searches of abandoned mines or caves can be dangerous and should only be conducted by trained researchers. For mine survey protocol and guidelines for protection of bat roosts, see the appendices in Pierson et al. (1999). Exit surveys at known roosts generally should be limited to non-invasive observation using low-light binoculars and infrared video cameras.

Multiple surveys will be required to determine the presence or absence of bats in caves and mines, and the number of surveys needed will vary by species of bats, sex (maternity or bachelor colony) of bats, seasonality of use, and type of roost structure (e.g., caves or mines). For example, Sherwin et al. (2003) demonstrated that a minimum of three surveys are needed to determine the absence of large hibernating colonies of Townsend's big-eared bats (*Corynorhinus townsendii*) in mines (90 percent probability), while a minimum of nine surveys (during a single warm season) are necessary before a mine could be eliminated as a bachelor roost for this species (90 percent probability). An average of three surveys was needed before surveyed caves could be eliminated as bachelor roosts (90 percent probability). It is recommended that decisions on level of effort follow discussion with relevant agencies and bat experts.

Activity Patterns

If active roosts are detected, it may be necessary to answer questions about behavior, movement patterns, and patterns of roost use for bat species of concern, or to further investigate habitat features that might attract bats and pose fatality risk. For some bat species, typically threatened, endangered, or state-listed species, radio telemetry or radar may be recommended to assess both the direction of movement as bats leave roosts, and the bats' use of the area being considered for development. Kunz et al. (2007) describe the use of telemetry, radar and other tools to evaluate use of roosts, activity patterns, and flight direction from roosts.

Mist-Netting for Bats

While mist-netting for bats is required in some situations by state agencies, Tribes, and the Service to determine the presence of threatened, endangered or other bat species of concern, mist-netting is not generally recommended for determining levels of activity or assessing risk of wind energy development to bats for the following reasons: 1) not all proposed or operational wind energy facilities offer conditions conducive to capturing bats, and often the number of suitable sampling points is minimal or not closely associated with the project location; 2) capture efforts often occur at water sources offsite or at nearby roosts and the results may not reflect species presence or use on the site where turbines are to be erected; and 3) mist-netting isn't feasible at the height of the rotor-swept zone, and captures below that zone may not adequately reflect risk of fatality. If mist-netting is employed, it is best used in combination with acoustic monitoring to inventory the species of bats present at a site.

White-Nose Syndrome

White-nose syndrome is a disease affecting hibernating bats. Named for the white fungus that appears on the muzzle and other body parts of hibernating bats, WNS is associated with extensive mortality of bats in eastern North America. All contractors and consultants hired by developers should employ the most current version of survey and handling protocols to avoid transmitting white-nose syndrome between bats.

Other wildlife

While the above guidance emphasizes the evaluation of potential impacts to birds and bats, Tier 1 and 2 evaluations may identify other species of concern. Developers are encouraged to assess adverse impacts potentially caused by development for those species most likely to be negatively affected by such development. Impacts to other species are primarily derived from potential habitat loss or displacement. The general guidance on the study design and methods for estimation of the distribution, relative abundance, and habitat use for birds is applicable to the study of other wildlife. Nevertheless, most methods and metrics will be species-specific and developers are advised to work with the state, tribal, or federal agencies, or other credible experts, as appropriate, during problem formulation for Tier 3.

4. What are the potential risks of adverse impacts of the proposed wind energy project to individuals and local populations of species of concern and their habitats? (In the case of rare or endangered species, what are the possible impacts to such species and their habitats?)

Methods used for estimating risk will vary with the species of concern. For example, estimating potential bird fatalities in Tier 3 may be accomplished by comparing exposure estimates (described earlier in estimates of bird use) at the proposed site with exposure estimates and fatalities at existing projects with similar characteristics (e.g., similar technology, landscape, and weather conditions). If models are used, they may provide an additional tool for estimating fatalities, and have been used in Australia (Organ and Meredith 2004), Europe (Chamberlin et al. 2006), and the United States (Madders and Whitfield 2006). As with other prediction tools, model predictions should be evaluated and compared with post-construction fatality data to validate the models. Models should be used as a subcomponent of a risk assessment based on the best available empirical data. A statistical model based on the relationship of pre-construction estimates of raptor abundance and post-construction raptor fatalities is described in Strickland et al. (in review) and promises to be a useful tool for risk assessment.

Collision risk to individual birds and bats at a particular wind energy facility may be the result of complex interactions among species distribution, relative abundance, behavior, weather conditions (e.g., wind, temperature) and site characteristics. Collision risk for an individual may be low regardless of abundance if its behavior does not place it within the rotor-swept zone. If individuals frequently occupy the rotor-swept zone but effectively avoid collisions, they are also at low risk of collision with a turbine (e.g., ravens). Alternatively, if the behavior of individuals frequently places them in the rotor-swept zone, and they do not actively avoid turbine blade strikes, they are at higher risk of collisions with turbines regardless of abundance. For a given species (e.g., red-tailed hawk), increased abundance increases the likelihood that individuals will be killed by turbine strikes, although the risk to individuals will remain about the same. The risk to a population increases as the proportion of individuals in the population at risk to collision increases.

At some projects, bat fatalities are higher than bird fatalities, but the exposure risk of bats at these facilities is not fully understood (National Research Council (NRC) 2007). Horn et al. (2008) and Cryan (2008) hypothesize that bats are attracted to turbines, which, if true, would further complicate estimation of exposure. Further research is required to determine if bats are attracted to turbines and if so, to evaluate 1) the influence on Tier 2 methods and predictions, and 2) if this increased individual risk translates into higher population-level impacts for bats.

The estimation of displacement risk requires an understanding of animal behavior in response to a project and its infrastructure, and a pre-construction estimate of presence/absence of species whose behavior would cause them to avoid areas in proximity to turbines, roads and other components of the project. The amount of habitat that is lost to indirect impacts will be a function of the sensitivity of individuals to the project and to the activity levels associated with the project's operations. The population-level significance of this habitat loss will depend on the amount of habitat available to the affected population. If the loss of habitat results in habitat fragmentation, then the risk to the demographic and genetic viability of the isolated animals is increased. Quantifying cause and effect may be very difficult, however.

5. If significant adverse impacts are predicted to species of concern, can these impacts be mitigated?

Comment [UF&WS2]: Note to FAC: How does a project developer design studies to answer this question? The information in the FAC Recommendations doesn't answer this question.

Results of Tier 3 studies should provide a basis for identifying measures to mitigate significant adverse impacts predicted for species of concern. Information on wildlife use of the proposed area is most useful when designing a project to avoid or minimize significant adverse impacts. In cases of uncertainty with regard to impacts to species of concern, additional studies may be necessary to quantify significant adverse impacts and determine the need for mitigation of those impacts.

The following discussion of prairie grouse and sage grouse as species of concern describes the present state of scientific knowledge relative to these species, which should be considered when designing mitigation measures. The extent of the impact of wind energy development on prairie grouse and sage grouse leking activity (e.g., social structure, mating success, persistence, etc.) and the associated impacts on productivity (e.g., nesting, nest success, chick survival, etc.) is poorly understood (Arnett et al. 2007, NRC 2007, Manville 2004). However, recent published research documents that anthropogenic features (e.g., tall structures, buildings, roads, transmission lines, etc.) can adversely impact vital rates (e.g., nesting, nest success, leking behavior, etc.) of lesser prairie-chickens (Pruett et al. 2009, Pitman et al. 2005, Hagen et al.

2009, Hagen et al. In press) and greater prairie-chickens (Robel, Pers Comm.) over long distances. Pitman et al. (2005) found that transmission lines reduced nesting of lesser prairie chicken by 90 percent out to a distance of 0.25 miles, improved roads at a distance of 0.25 miles, a house at 0.3 miles, and a power plant at >0.6 miles. Reduced nesting activity of lesser prairie chickens may extend farther, but Pitman et al. (2005) did not analyze their data for lower impacts (less than 90 percent reduction in nesting) of those anthropogenic features on lesser prairie chicken nesting activities at greater distances. Hagen et al. (In press) suggested that development within 1 to 1 ½ miles of active leks of prairie grouse may have significant adverse impacts on the affected grouse population. It is not unreasonable to infer that impacts from wind energy facilities may be similar to those from these other anthropogenic structures. Kansas State University, as part of the NWCC GS3C, is undertaking a multi-year telemetry study to evaluate the effects of a proposed wind-energy facility on displacement and demographic parameters (survival, nest success, brood success, fecundity) of greater prairie-chickens in Kansas.[3]

Comment [UF&WS3]: Note to FAC: This was in FAC recommendations. Is there published literature we can now reference?

The distances over which anthropogenic activities impact sage grouse are greater than for prairie grouse. Based primarily on data documenting reduced fecundity (a combination of nesting, clutch size, nest success, juvenile survival, and other factors) in sage grouse populations near roads, transmissions lines, and areas of oil and gas development/production (Holloran 2005, Connelly et al. 2000), development within three to five miles (or more) of active sage grouse leks may have significant adverse impacts on the affected grouse population. Lyon and Anderson (2003) found that in habitats fragmented by natural gas development, only 26 percent of hens captured on disturbed leks nested within 1.8 miles of the lek of capture, whereas 91 percent of hens from undisturbed areas nested within the same area. Holloran (2005) found that active drilling within 3.1 miles of sage grouse lek reduced the number of breeding males by displacing adult males and reducing recruitment of juvenile males. The magnitudes and proximal causes (e.g., noise, height of structures, movement, human activity, etc.) of those impacts on vital rates in grouse populations are areas of much needed research (Becker et al. 2009). Data accumulated through such research may improve our understanding of the buffer distances necessary to avoid or minimize significant adverse impacts to prairie grouse and sage grouse populations.

[3] www.nationalwind.org

When significant adverse impacts cannot be fully avoided or adequately minimized, some form of compensatory mitigation may be appropriate to address the loss of habitat value. For example, it may be possible to mitigate habitat loss or degradation for a species of concern by enhancing or restoring nearby habitat value comparable to that potentially influenced by the project.

6. Are there studies that should be initiated at this stage that would be continued in either Tier 4 or Tier 5?

During Tier 3 problem formulation, it is necessary to identify the studies needed to address the Tier 3 questions. Consideration of how the resulting data may be used in conjunction with post-construction Tier 4 and 5 studies is also recommended. The design of post-construction impact or mitigation assessment studies will depend on the specific impact questions being addressed. Tier 3 predictions of fatalities will be evaluated using data from Tier 4 studies designed to estimate fatalities. Tier 3 studies may demonstrate the need for compensatory mitigation of significant adverse habitat impacts or for measures to avoid or minimize fatalities. Where significant adverse habitat impacts are of major concern, Tier 5 studies will provide data that evaluate the predicted impacts and the effectiveness of avoidance, minimization and mitigation measures. Evaluation of the impact of a project on demographic parameters of local populations, habitat use, or some other parameter(s), typically will require data on these parameters prior to and after construction of the project.

Tier 3 Decision Point

At the end of Tier 3, developers should coordinate with the Service to complete the Tier 3 decision process. The Service will provide written comments to a developer on study and project development plans that identify concerns and recommendations to resolve the concerns. The developer and when applicable, the permitting authority, will make a decision regarding whether and how to develop the project. The decision point at the end of Tier 3 involves three potential outcomes:

1. Development of the site has a low probability of significant adverse impact based on existing and new information.

There is little uncertainty regarding when and how development should proceed, and adequate information exists to satisfy any required permitting. The decision process proceeds to permitting, when required, and/or development, and post-construction monitoring.

2. Development of the site has a moderate to high probability of significant adverse impacts without proper measures being taken to mitigate those impacts. This outcome may be subdivided into two possible scenarios:

    a. There is certainty regarding how to develop the site to adequately mitigate significant adverse impacts. A decision to develop the site is made, conditional on the proper mitigation measures being adopted, with appropriate follow-up fatality monitoring (Tier 4) and habitat studies, if necessary (Tier 5).

    b. There is uncertainty regarding how to develop the site to adequately mitigate significant adverse impacts, or a permitting process requires additional information on potential significant adverse wildlife impacts before permitting future phases of the project. A decision to develop the site is made conditional on the proper mitigation measures being taken and with appropriate follow up post-construction studies (Tier 4 and 5).

3. Development of the site has a high probability of significant impact that cannot be satisfactorily mitigated.

Site development is delayed until plans can be developed that satisfactorily avoid, minimize or provide compensatory mitigation for the significant adverse impacts. Alternatively, the site is abandoned in favor of known sites with less potential for environmental impact, or the developer begins an evaluation of other sites or landscapes for more acceptable sites to develop.

Where pre-construction assessments are warranted to help assess risk to wildlife, the studies should be of sufficient duration and intensity to ensure adequate data are collected to accurately characterize wildlife use of the area. In ecological systems, resource quality and quantity can fluctuate rapidly. These fluctuations occur naturally, but human actions can significantly affect (i.e., increase or decrease) natural oscillations. Pre-construction monitoring and assessment of proposed wind energy sites are “snapshots in time,” showing occurrence or no occurrence of a species or habitat at the specific time surveyed. Often due to prohibitive costs, assessments and surveys are conducted for very low percentages (e.g., less than 5 percent) of the available sample time in a given year, however, these data are used to support risk analyses over the projected life of a project (e.g., 30 years of operations).

To establish a trend in site use and conditions that incorporates annual and seasonal variation in meteorological conditions, biological factors, and other variables, pre-construction studies may need to occur over multiple years. However, the level of risk and the question of data requirements will be based on site sensitivity, affected species, and the availability of data from other sources. Accordingly, decisions regarding the studies required should consider information gathered during the previous tiers, variability within and between seasons, and years where variability is likely to substantially affect answers to the Tier 3 questions. These studies should also be designed to collect data during relevant breeding, feeding, sheltering, staging, or migration periods for each species being studied. Additionally, consideration for the frequency and intensity of pre-construction monitoring should be site-specific and determined through consultation with an expert authority based on their knowledge of the specific species, level of risk and other variables present at each individual site. Some tools have been developed for existing guidance to evaluate sites based on risk criteria.

Chapter 5

Tier 4 – Post-construction Monitoring

Following the tiered decision process, the outcome of Tier 1 to 3 studies will determine the duration and level of effort of Tier 4 monitoring.

Tier 4 monitoring focuses specifically on post-construction monitoring. Activities involve searching for bird and bat carcasses beneath turbines to estimate the number and species composition of fatalities, determining whether species are being displaced by the facility, and whether the habitat has been fragmented. This information may be useful in answering other questions such as relationships with site characteristics, comparison of fatalities among facilities, and comparison of actual and predicted fatality rates estimated in previous tiers.

Fatality monitoring should be conducted at all wind energy projects. Fatality monitoring should occur over all seasons of occupancy for the species being monitored, based on information produced in previous tiers. The number of seasons and total length of the monitoring may be determined separately for bats and birds, depending on the pre-construction risk assessment, results of Tier 3 studies and Tier 4 monitoring from comparable sites (see Glossary), and the results of first year fatality monitoring**.** It may be appropriate to conduct monitoring using different durations and intervals depending on the species of concern. For example, if raptors occupy an area year-round, it may be appropriate to monitor for raptors throughout the year (12 months). It may be warranted to monitor for bats when they are active (spring, summer and fall or approximately eight months). It may be appropriate to increase the search frequency during the months bats are active and decrease the frequency during periods of inactivity. All fatality monitoring should include estimates of carcass removal and carcass detection bias likely to influence those rates.

Habitat studies may not necessarily be conducted at all projects. However, this should be considered when it is identified as a potential risk and/or when species of habitat fragmentation concern have been identified in the project area.

The developer's decision about the number of years of study should follow discussions with relevant agencies. The decision should be based on Table 1. The number of years of monitoring is indicated by outcomes of both Tier 3 and Tier 4 analysis as indicated in the table below:

Table 1. Survey Decision Support Matrix Tool for Post-construction Tier 4 Monitoring.[4]

Risk of Significant Adverse Impact identified in Tier 3	Recommended Duration and Effort	Possible outcomes of monitoring results
LOW	**Duration**: Field assessments should be sufficient to validate effects to birds and bats. Monitoring should follow standard protocols. **Effort**: Monitoring should be conducted at least during all seasons in which a species may be present and during all times of a species' daily cycle and in conditions within which a bird and/or bat may fly.	1) Risk level validated – documented fatalities are equal to or lower than predicted risk. The Service will provide a recommendation to the developer on whether the current level of study effort is sufficient. 2) Mortality greater than predicted is documented. Adaptive management actions should be implemented. Additional monitoring duration and intensity may be recommended.
MODERATE	**Duration**: Multiple years may be necessary Field assessments should be sufficient to validate with a statistically significant degree of certainty that risk to birds and/or bats was indeed "moderate." Closely compare validated effects to species to those determined from the risk assessment protocol(s). **Effort**: Monitoring should be conducted at least during all seasons in which a species may be present and during all times of a species' daily cycle and in conditions within which a bird and/or bat may fly.	1) Documented fatalities are equal to or lower than predicted risk. Current study effort and duration may be sufficient. 2) Risk level validated – documented fatalities are equal to or lower than predicted risk with mitigation. A decision is required on future levels of monitoring after initial multi-year assessment.
HIGH	**Duration**: Additional years beyond the "Moderate" level may be recommended Where the risks to species are determined to be "high," this determination must be quantified in regard to the status, vulnerability, chronology, and adverse effects to each affected species.	1) Documented fatalities are equal to or lower than predicted risk with mitigation. The developer should communicate with the Service to determine future levels of monitoring after initial multi-year assessment.

[4] Ensure that survey protocols, and searcher efficiency and scavenger removal bias correction factors are the most reliable, robust, and up to date (after Huso 2009).

	Effort: Monitoring should be conducted at least during all seasons in which a species may be present and during all times of a species' daily cycle and in conditions within which a bird and/or bat may fly.	2) Mortality is greater than predicted is documented. Adaptive management actions are required. Additional studies may be recommended by the Service and the developer should consider implementing operational modifications to reduce take.

Tier 4 Post-construction Monitoring Examples

Wind energy development varies considerably across the country. This affects the minimum number of years for post-construction monitoring. For example, a wind energy project located near a listed species or golden eagle may require a longer duration and greater intensity of monitoring than a project in an active agricultural field. One year of post-construction monitoring may be appropriate for the agricultural field, but not for the project near listed species or golden eagles. The Service may recommend multiple years of monitoring for listed species or golden eagles, or in other appropriate situations.

Tier 4 Questions

Post-construction fatality monitoring activities are designed to answer the following questions as appropriate for the individual project:

1. What are the bird and bat fatality rates for the project?
2. What are the fatality rates of species of concern?
3. How do the estimated fatality rates compare to the predicted fatality rates?
4. Do bird and bat fatalities vary within the project site in relation to site characteristics?
5. How do the fatality rates compare to the fatality rates from existing projects in similar landscapes with similar species composition and use?
6. What is the composition of fatalities in relation to migrating and resident birds and bats at the site? Do fatality data suggest the need for measures to reduce impacts?
7. What are the effects of habitat loss, modification, and fragmentation on species of habitat fragmentation concern?
8. Were any behavioral modifications or displacement noted in regard to affected species?

Fatality monitoring results should be of sufficient statistical validity to answer Tier 4 questions, allow comparisons with pre-construction impact predictions and comparisons with other sites, and provide a basis for determining if corrective management or mitigation measures at the site are appropriate.

Tier 4 Protocol Design Issues

The basic method of measuring fatality rates is the carcass search. Search protocols should be standardized to the greatest extent possible, especially for common objectives and species of concern, and they should include methods for adequately accounting for sampling biases (searcher efficiency and scavenger removal). However, some situations warrant exceptions to standardized protocol, and the responsibility of demonstrating that an exception is appropriate and applicable should be on the stakeholder attempting to justify increasing or decreasing the duration or intensity of operations monitoring.

Some general guidance is given below with regard to the following fatality search protocol design issues:

- Duration and frequency of monitoring
- Number of turbines to monitor
- Delineation of carcass search plots, transects, and habitat mapping
- General search protocol
- Field bias and error assessment
- Estimators of fatality
- More detailed descriptions and methods of fatality search protocols can be found in the California (California Energy Commission 2007) and Pennsylvania (Pennsylvania Game Commission 2007) state guidelines and in Kunz et al. (2007) and Smallwood (2007).
- Frequency of carcass searches

Frequency of carcass searches (search interval) may vary for birds and bats, and will vary depending on the questions to be answered, the species of concern, and their seasonal abundance at the project site. The carcass searching protocol should be adequate to answer applicable Tier 4 questions at an appropriate level of precision to make general conclusions about the project, and is not intended to provide highly precise measurements of fatalities. Except during low use times (e.g. winter months in northern states), it is recommended that protocols be designed such that carcass searches occur at some turbines within the project area most days each week of the study.

The search interval is the interval between carcass searches at individual turbines, and this interval may be lengthened or shortened depending on the carcass removal rates. If the primary focus is on fatalities of large raptors, where carcass removal is typically low, then a longer interval between searches (e.g., 14-28 days) is sufficient. However, if the focus is on fatalities of bats and small birds and carcass removal is high, then a shorter search interval will be necessary.

There are situations in which studies of higher intensity (e.g., daily searches at individual turbines within the sample) may be appropriate. These would be considered only in Tier 5 studies or in research programs because the greater complexity and level of effort goes beyond that recommended for typical Tier 4 post construction monitoring. Tier 5 and research studies could include evaluation of specific measures that have been implemented to mitigate potential significant adverse impacts to species of concern identified during pre-construction studies.

Number of turbines to monitor

If available, data on variability among turbines from existing projects in similar conditions within the same region are recommended as a basis for determining needed sample size (see Morrison et al., 2008). If data are not available, it is recommended that a sufficient number of turbines be selected via a systematic sample with a random start point. Sampling plans can be varied (e.g., rotating panels [McDonald 2003, Fuller 1999, Breidt and Fuller 1999, and Urquhart et al. 1998]) to increase efficiency as long as a probability sampling approach is used. If the project contains fewer than 10 turbines, it is recommended that all turbines in the area of interest be searched unless otherwise agreed to by the permitting or wildlife resource agencies. When selecting turbines, it is recommended that a systematic sample with a random start be used when selecting search plots to ensure interspersion among turbines. Stratification among different habitat types also is recommended to account for differences in fatality rates among different habitats (e.g., grass versus cropland or forest); a sufficient number of turbines should be sampled in each strata.

Delineation of carcass search plots, transects, and habitat mapping

Evidence suggests that greater than 80 percent of bat fatalities fall within half the maximum distance of turbine height to ground (Erickson 2003 a, b), and a minimum plot width of 120 meters from the turbine should be established at sample turbines. Plots will need to be larger for birds, with a width twice the turbine height to ground. Decisions regarding search plot size should be made in discussions with the Service, state wildlife agency, permitting agency and Tribes. It may be useful to consult other scientifically credible information sources.

It is recommended that each search plot should be divided into oblong subplots or belt transects and that each subplot be searched. The objective is to find as many carcasses as possible so the width of the belt will vary depending on the ground cover and its influence on carcass visibility. In most situations, a search width of 6 meters should be adequate, but this may vary from 3-10 meters depending on ground cover.

Searchable area within the theoretical maximum plot size varies, and heavily vegetated areas (e.g., eastern mountains) often do not allow surveys to consistently extend to the maximum plot width. In other cases it may be preferable to search a portion of the maximum plot instead of the entire plot. For example, in some landscapes it may be impractical to search the entire plot because of the time required to do an effective search, even if it is accessible (e.g., croplands), and data from a probability sample of subplots within the maximum plot size can provide a reasonable estimate of fatalities. It is important to accurately delineate and map the area searched for each turbine to adjust fatality estimates based on the actual area searched. It may be advisable to establish habitat visibility classes in each plot to account for differential detectability, and to develop visibility classes for different landscapes (e.g., rocks, vegetation) within each search plot. For example, the Pennsylvania Game Commission (2007) identified four classes based on the percentage of bare ground.

The use of visibility classes requires that detection and removal biases be estimated for each class. Fatality estimates should be made for each class and summed for the total area sampled. Global positioning systems (GPS) are useful for accurately mapping the actual total area searched and area searched in each habitat visibility class, which can be used to adjust fatality estimates. The width of the belt or subplot searched may vary depending on the habitat and species of concern; the key is to determine actual searched area and area searched in each visibility class regardless of transect width. An adjustment may also be needed to take into account the density of fatalities as a function of the width of the search plot.

<u>General search protocol guidance</u>

Personnel trained in proper search techniques should look for bird and bat carcasses along transects or subplots within each plot and record and collect all carcasses located in the searchable areas. A developer should obtain a Special Purpose Salvage for Utilities-Wind permit to collect and possess bird carcasses. A complete search of the area should be accomplished and subplot size (e.g., transect width) should be adjusted to compensate for detectability differences in the search area. Subplots should be smaller when vegetation makes it difficult to detect carcasses; subplots can be wider in open terrain. Subplot width also can vary depending on the size of the species being looked for. For example, small species such as bats may require smaller subplots than larger species such as raptors.

Data to be recorded include date, start time, end time, observer, which turbine area was searched (including GPS coordinates) and weather data for each search. When a dead bat or bird is found, the searcher should place a flag near the carcass and continue the search. After searching the entire plot, the searcher returns to each carcass and records information on a fatality data sheet, including date, species, sex and age (when possible), observer name, turbine number, distance from turbine, azimuth from turbine (including GPS coordinates), habitat surrounding carcass, condition of carcass (entire, partial, scavenged), and estimated time of death (e.g., ≤1 day, 2 days). The recorded data will ultimately be housed in the FWS Office of Law Enforcement Bird Mortality Reporting System. A digital photograph of the carcass should be taken. Rubber gloves should be used to handle all carcasses to eliminate possible transmission of rabies or other diseases and to reduce possible human scent bias for carcasses later used in scavenger removal trials. Carcasses should be placed in a plastic bag and labeled. Fresh carcasses (those determined to have been killed the night immediately before a search) should be redistributed at random points on the same day for scavenging trials.

Field bias and error assessment

It has long been recognized that during searches conducted at wind turbines, actual fatalities are incompletely observed and that therefore carcass counts must be adjusted by some factor that accounts for imperfect detectability. Important sources of bias and error include: 1) fatalities that occur on a highly periodic basis; 2) carcass removal by scavengers; 3) differences in searcher efficiency; 4) failure to account for the influence of site (e.g. vegetation) conditions in relation to carcass removal and searcher efficiency; and 5) fatalities or injured birds and bats that may land or move outside search plots.

Some fatalities may occur on a highly periodic basis creating a potential sampling error (number 1 above). It is recommended that sampling be scheduled so that some turbines are searched most days and episodic events are more likely detected, regardless of the search interval. To address bias sources 2-4 above, it is strongly recommended that all fatality studies conduct carcass removal and searcher efficiency trials using accepted methods (Anderson 1999, Kunz et al. 2007, Arnett et al. 2007, NRC 2007). Bias trials should be conducted throughout the entire study period and searchers should be unaware of which turbines are to be used or the number of carcasses placed beneath those turbines during trials. Carcasses or injured individuals may land or move outside the search plots (number 5 above). With respect to Tier 4 fatality estimates, this potential sampling error is considered to be small and can be ignored.

Prior to a study's inception, a list of random turbine numbers and random azimuths and distances (in meters) from turbines should be generated for placement of each bat or bird used in bias trials. Data recorded for each trial carcass prior to placement should include date of placement, species, turbine number, distance and direction from turbine, and visibility class surrounding the carcass. Trial carcasses should be distributed as equally as possible among the different visibility classes throughout the study period and study area. Studies should attempt to avoid "over-seeding" any one turbine with carcasses by placing no more than one or two carcasses at any one time at a given turbine. Before placement, each carcass must be uniquely marked in a manner that does not cause additional attraction, and its location should be recorded. There is no agreed upon sample size for bias trials, though some state guidelines recommend from 50 - 200 carcasses.

Estimators of fatality

If there were a direct relationship between the number of carcasses observed and the number killed, there would be no need to develop a complex estimator that adjusts observed counts for detectability, and observed counts could be used as a simple index of fatality. But the relationship is not direct and raw carcass counts recorded using different search intervals and under different carcass removal rates and searcher efficiency rates are not directly comparable. It is strongly recommended that only the most contemporary equations for estimating fatality be used, as some original versions are now known to be extremely biased under many commonly encountered field conditions (Strickland et al. In review, Erickson et al. 2000b, Erickson et al. 2004, Johnson et al. 2003, Kerns and Kerlinger 2004, Fiedler et al. 2007, Kronner et al. 2007, Smallwood 2007).

Tier 4 Methods and Metrics

In addition to the monitoring protocol, the metrics used to estimate fatality rates must be selected with the Tier 4 questions and objectives in mind. Metrics considerations for each of the Tier 4 questions are discussed briefly below. Not all questions will be relevant for each project, and which questions apply would depend on Tier 3 outcomes.

1. What are the bird and bat fatality rates for the project?

The primary objective of fatality searches is to determine the overall estimated fatality rates for birds and bats for the project. These rates serve as the fundamental basis for all comparisons of fatalities, and if studies are designed appropriately they allow researchers to relate fatalities to site characteristics and environmental variables, and to evaluate mitigation measures. Several metrics are available for expressing fatality rates. Early studies reported fatality rates per turbine. However, this metric is somewhat misleading as turbine sizes and their risks to birds vary significantly (NRC 2007). Fatalities are frequently reported per nameplate capacity (i.e. MW), a metric that is easily calculated and better for comparing fatality rates among different sized turbines. Even with turbines of the same name plate capacity, the size of the rotor swept area may vary among manufacturers, and turbines at various sites may operate for different lengths of time and during different times of the day and seasons. With these considerations in mind, it is recommended that fatality rates be expressed on a per turbine and per nameplate MW basis until a better metric becomes available.

2. What are the fatality rates of species of concern?

This analysis simply involves calculating fatalities per turbine of all species of concern at a site when sample sizes are sufficient to do so. These fatalities should be expressed on a per nameplate MW basis if comparing species fatality rates among projects.

3. How do the estimated fatality rates compare to the predicted fatality rates?

There are a several ways that predictions can be assigned and later evaluated with actual fatality data. During the planning stages in Tier 2, predicted fatalities may be based on existing data at similar facilities in similar landscapes used by similar species. In this case, the assumption is that use is similar, and therefore that fatalities may be similar at the proposed facility. Alternatively, metrics derived from pre-construction assessments for an individual species or group of species – usually an index of activity or abundance at a proposed project – could be used in conjunction with use and fatality estimates from existing projects to develop a model for predicting fatalities at the proposed project site. Finally, physical models can be used to predict the probability of a bird of a particular size striking a turbine, and this probability, in conjunction with estimates of use and avoidance behavior, can be used to predict fatalities.

The most current equations for estimating fatality should be used to evaluate fatality predictions. Several statistical methods can be found in the revised Strickland et al. (in review) and used to evaluate fatality predictions. Metrics derived from Tier 3 pre-construction assessments may be correlated with fatality rates, and (using the project as the experimental unit), in Tier 5 studies it should be possible to determine if different preconstruction metrics can in fact accurately predict fatalities and, thus, risk.

4. How do the fatality rates compare to the fatality rates from existing facilities in similar landscapes with similar species composition and use?

Comparing fatality rates among facilities with similar characteristics is useful to determine patterns and broader landscape relationships, as is discussed in some detail above for predicting fatalities at a proposed project site. Fatality rates should be expressed on a per nameplate MW or some other standardized metric basis for comparison with other projects, and may be correlated with site characteristics – such as proximity to wetlands, riparian corridors, mountain-foothill interface, or other broader landscape features – using regression analysis. Comparing fatality rates from one project to fatality rates of other projects provides insight into whether a project has relatively high, moderate or low fatalities.

5. Do bird and bat fatalities vary within the project site in relation to site characteristics?

Turbine-specific fatality rates may be related to site characteristics such as proximity to water, forest edge, staging and roosting sites, known stop-over sites, or other key resources, and this relationship may be estimated using regression analysis. This information is particularly useful for evaluating micro-siting options when planning a future facility or, on a broader scale, in determining the location of the entire project.

6. What is the composition of fatalities in relation to migrating and resident birds and bats at the site?

The simplest way to address this question is to separate fatalities per turbine of known resident species (e.g., big brown bat, prairie horned lark) and those known to migrate long distances (e.g. hoary bat, red-eyed vireo). These data are useful in determining patterns of species composition of fatalities and possible mitigation measures directed at residents, migrants, or perhaps both, and can be used in assessing potential population effects.

7. Do fatality data suggest the need for measures to reduce impacts?

It is recommended that the wind project operator[5] and the relevant agencies discuss the results from Tier 4 studies to determine whether these impacts are significant. If fatalities are considered significant, the wind project operator and the relevant agencies should develop a plan to mitigate the impacts.

8. What are the effects of habitat loss, modification, and fragmentation on species of habitat fragmentation concern?

To assess the effects of habitat loss or modification, habitat assessments within the project area begun in Tier 3 should continue. Habitat types should be mapped and assessments of habitat quality should be conducted and recorded. Habitat data should be maintained consistent with other geo-spatial data.

Key indications of habitat quality should be the focus of such monitoring. Depending on the affected species within the area of influence, specific components of habitat should be identified and measured to determine if habitat loss and degradation are occurring Other indicators of habitat quality include aspects of the aquatic environment, including shade, pool frequency and depth, and freedom from excessive sedimentation. It is important to remember that wind development projects include road construction and maintenance, and other earth-moving activities that can have an effect on the aquatic community if not properly planned and conducted. For instance, a road parallel to a stream will disrupt the natural recruitment of trees

[5] In situations where a project operator was not the developer, the Service expects that obligations of the developer for adhering to the Guidelines transfer with the project.

into the stream and may result in less large pool-forming wood as well as excessive road-generated sediment.

To assess the effects of habitat fragmentation on wildlife, monitoring programs must target variables that imply a change due to the construction of the wind facility. Appropriate effects to monitor include changes in species composition, reduced survival, reduced productivity, and altered use of the project site (both increased and decreased use). If monitoring indicates significant differences between pre-construction assessments and what is actually occurring, project operators should consider further evaluation of habitat fragmentation in Tier 5 research and development of a mitigation plan.

9. Were any behavioral modifications or displacement noted in regard to affected species?

Displacement is considered a potentially adverse effect to species and can result from a species' avoidance of noise, structures, and/or human presence. Monitoring may be necessary to determine the extent of these effects and the need for mitigation. The Service recognizes that monitoring of displacement may not be appropriate for all individual projects.

Monitoring for displacement of affected species caused by project development requires the comparison of baseline conditions (i.e., Tier 3 information) to data collected after construction and operation begins. Factors that might increase displacement include noise, increase in human activity, and presence of structures. By conducting pre- and post-construction local population surveys, such information should become available indicating whether disturbance and other factors are affecting species of concern within the project site. Where displacement is suspected, the developer should attempt to assess the effects, if any, during Tier 4. Such verification that displacement is occurring, and determining its causative factors, should follow during Tier 5 research.

Tier 4 Decision Points and Follow-up Actions

The purpose of Tier 4 monitoring is to collect information to compare actual impacts to species of concern of project operations relative to the wildlife impacts anticipated. If during the first year(s) of post-construction monitoring, the actual impacts are less than or approximately the same as those predicted, less rigorous monitoring for shorter periods may be appropriate. If post construction monitoring finds that actual impacts to species of concern are greater than anticipated, including with mitigation completed, project developers/operators should undertake additional monitoring. Monitoring should inform additional coordination with the Service regarding ways to reduce the impacts to species of concern through adaptive management.

Chapter 6

Tier 5 – Other Post-construction Studies

Tier 5 studies will not be necessary for most wind energy projects. Tier 5 studies can be complex and time consuming. The Service anticipates that the tiered approach will steer projects away from sites where Tier 5 studies would be necessary.

When Tier 5 studies are conducted, they will be site-specific and intended to: 1) evaluate the direct and indirect effects (e.g., displacement) of significant adverse habitat impacts on species of concern; 2) analyze factors associated with impacts, particularly direct impacts, in those cases in which impacts significantly exceed pre-construction predictions; 3) identify additional actions as warranted when mitigation measures implemented for a project are not adequate; and 4) assess demographic effects on local populations of species of concern.

Tier 5 Questions

Tier 5 studies are intended to answer questions that fall in three major categories; answering yes to any of these questions might indicate a Tier 5 study is needed:

1. Are post-construction impacts significantly higher than pre-construction estimates for direct and indirect impacts on species of concern and their habitat determined to be of interest in Tier 3?

   For example, in the Tier 3 risk assessment, predictions of collision fatalities and habitat impacts (direct and indirect) are developed. Post-construction studies in Tiers 4 and 5 evaluate the accuracy of those predictions by estimating impacts. If post-construction studies demonstrate higher levels of adverse impact than predicted, Tier 5 studies may also be warranted. Such Tier 5 studies will be unusual and will not apply to most projects.

2. Have habitat mitigation measures implemented (other than fee in lieu) been ineffective? If habitat restoration is conducted, it may be desirable to monitor the restoration efforts to determine if there is replacement of habitat conditions.

Have measures undertaken to reduce collision fatalities been significantly less effective than anticipated?

One objective of Tier 4 studies is to assess the effectiveness of measures undertaken to reduce fatalities as part of the project and to identify such alternative or additional measures as are necessary. If Tier 4 studies indicate that collision fatalities and adverse habitat impacts are higher than predicted, there may be additional or alternative mitigation measures which should be explored. The effectiveness of these additional measures would be evaluated using Tier 5 studies.

3. Are the estimated impacts of the proposed project likely to lead to population declines in the species of concern (other than federally-listed species)?

Impacts of a project will have population level effects if the project causes a population decline in the species of concern.

For non-listed species, this assessment will apply only to the local population.

Circumstances in which Tier 5 studies may be conducted include:

1) When realized fatality levels for individual species of concern reach a level at which they are considered significant adverse impacts by the relevant agencies.

For example, if Tier 4 fatality studies document that a particular turbine or set of turbines exhibits bird or bat collision fatality higher than predicted, adaptive management (as defined in Chapter Two-B) may be useful in evaluating alternative measures to avoid or minimize future fatalities at that turbine/turbine string.

2) There is the potential for significant fatality impacts or significant adverse impacts to habitat for species of concern, there is a need to assess the impacts more closely, and there is uncertainty over how these impacts will be mitigated.

3) When fatality and/or significant adverse habitat impacts suggest the potential for a reduction in the viability of an affected population, in which case studies on the potential for population impacts may be warranted.

4) When a developer evaluates the effectiveness of a risk reduction measure before deciding to continue the measure permanently or whether to use the measure when implementing future phases of a project.

In the event additional turbines are proposed as an expansion of an existing project, results from Tier 4 and Tier 5 studies and the decision-making framework contained in the tiered approach can be used to determine whether the project should be expanded and whether additional information should be collected. It may also be necessary to evaluate whether additional measures are warranted to reduce significant adverse impacts to species.

Tier 5 Study Design Issues

Because Tier 5 studies will be highly variable and unique to the circumstances of the individual project, these Guidelines do not provide specific guidance on all potential approaches, but make some general statements about study design. Specific Tier 5 study designs will depend on the types of questions, the specific project, and practical considerations. The most common practical considerations include the area being studied, the time period of interest, the species of concern, potentially confounding variables, time available to conduct studies, project budget, and the magnitude of the anticipated impacts.

In the context of wind energy development, when it is possible to collect data both pre- and post-construction in the areas of interest and reference areas are available, then the Before-After-Control-Impact (BACI) is the most statistically robust design. The BACI design is most like the classic manipulative experiment.[6] In the absence of a suitable reference area, the design is

[6] In this context, such designs are not true experiments in that the treatments (project development and control) are not randomly assigned to an experimental unit, and there is often no true replication. Such constraints are not fatal flaws, but do limit statistical inferences of the results.

reduced to a Before-After (BA) analysis of effect where the differences between pre- and post-construction parameters of interest are assumed to be the result of the project, independent of other potential factors affecting the assessment area. With respect to BA studies, the key question is whether the observations taken immediately after the incident can reasonably be expected within the expected range for the system (Manly 2009). Reliable quantification of impact usually will include additional study components to limit variation and the confounding effects of natural factors that may change with time.

In some situations, the timeline for the development of a wind energy facility does not allow for the collection of pre-construction data that are useful for research purposes, especially when suitable reference areas are lacking. Furthermore, alterations in land use or disturbance over the course of a multi-year BACI or BA study may complicate the analysis of study results.

Comment [UF&WS4]: Note to FAC: See added language; is this what the Committee meant to say?

When pre-construction data are unavailable and/or a suitable reference area is lacking, the reference Control Impact Design (Morrison et al. 2008) is the recommended design. The lack of a suitable reference area also can be addressed using the Impact Gradient Design, when habitat and species use are homogenous in the assessment area prior to development. When applied both pre- and post-construction, the Impact Gradient Design is a suitable replacement for the classic BACI (Morrison et al. 2008).

In the study of habitat impacts, the resource selection function (RSF) study design (see Anderson et al 1999; Morrison et al. 2008; Manly et al. 2002) is a statistically robust design, either with or without pre-construction and reference data. Habitat selection is modeled as a function of characteristics measured on resource units and the use of those units by the animals of interest. The RSF allows the estimation of the probability of use as a function of the distance to various environmental features, including wind energy facilities, and thus provides a direct quantification of the magnitude of the displacement effect. RSF could be improved with pre-construction and reference area data. Nevertheless, it is a relatively powerful approach to documenting displacement or the effect of mitigation measures designed to reduce displacement even without those additional data.

Tier 5 Examples

As described earlier, Tier 5 studies will not be conducted at most projects, and the specific Tier 5 questions and methods for addressing these questions will depend on the individual project and the concerns raised during pre-construction studies and during operational phases. Rather than provide specific guidance on all potential approaches, these Guidelines offer the following case studies as examples of studies that have attempted to answer Tier 5 questions.

1. Habitat impacts - displacement and demographic impact studies

Studies to assess impacts may include quantifying species' habitat loss (e.g., acres of lost grassland habitat for grassland songbirds) and habitat modification. For example, an increase in edge may result in greater nest parasitism and nest predation. Assessing indirect impacts may include two important components: 1) indirect effects on wildlife resulting from displacement, due to disturbance, habitat fragmentation, loss, and alteration and 2) demographic effects that may occur at the local, regional or population-wide levels due to reduced nesting and breeding densities, increased isolation between habitat patches, and effects on behavior (e.g., stress, interruption, and modification). These factors can individually or cumulatively affect wildlife, although some species may be able to habituate to some or perhaps all habitat changes. Indirect impacts may be difficult to quantify but their effects may be significant (e.g., Stewart et al. 2007, Pearce-Higgins et al. 2008, Bright et al. 2008, Drewitt and Langston 2006, Robel et al. 2004, Pruett et al. 2009).

Example: in southwestern Pennsylvania, development of a project is proceeding at a site located within the range of a state-listed terrestrial species. Surveys were performed at habitat locations appropriate for use by the animal, including at control sites. Post-construction studies are planned at all locations to demonstrate any displacement effects resulting from the construction and operation of the project.

The Service recognizes that displacement studies may not be appropriate for most individual projects. Consideration should be given to developing collaborative research efforts with industry, government agencies, and NGOs to conduct studies to address displacement.

Displacement is considered a potentially significant adverse impact to species such as prairie grouse (prairie chickens, sharp-tailed grouse), and sage grouse, and displacement studies may be necessary to determine the extent of these impacts and the need for mitigation.

Displacement studies may use any of the study designs describe earlier. The most scientifically robust study designs to estimate displacement effects are BACI, RSF, and impact gradient. RSF and impact gradient designs may not require specialized data gathering during Tier 3.

Telemetry studies that measure impacts of the project development on displacement, nesting, nest success, and survival of prairie grouse and sage grouse in different environments (e.g., tall grass, mixed grass, sandsage, sagebrush) will require spatial and temporal replication, undisturbed reference sites, and large sample sizes covering large areas. Examples of study designs and analyses used in the studies of other forms of energy development are presented in Holloran et al. (2005), Pitman et al. (2005), and Robel et al. (2004). Anderson et al. (1999) provides a thorough discussion of the design, implementation, and analysis of these kinds of field studies and should be consulted when designing the BACI study.

Studies are being initiated to evaluate effects of wind energy development on greater sage grouse in Wyoming. In addition to measuring demographic patterns, these studies will use the RSF study design (see Sawyer et al. 2006) to estimate the probability of sage grouse use as a function of the distance to environmental features, including an existing and a proposed project.

In certain situations, such as for a proposed project site that is relatively small and in a more or less homogeneous landscape, an impact gradient design may be an appropriate means to assess impacts of the wind energy facility on resident populations (Strickland et al., 2002). For example, Leddy et al. 1999 used the impact gradient design to evaluate grassland bird density as a function of the distance from wind turbines. Data were collected at various distances from turbines along transects.

This approach provides information on whether there is an effect, and may allow quantification of the gradient of the effect and the distance at which the effect no longer exists – the assumption being that the data collected at distances beyond the influence of turbines are the reference data (Erickson et al., 2007). An impact gradient analysis could also involve measuring the number of breeding grassland birds counted at point count plots as a function of distance from the wind turbines (Johnson et al. 2000).

<u>Sound and Wildlife</u>

Turbine blades at normal operating speeds can generate levels of sound beyond ambient background levels. Construction and maintenance activities can also contribute to sound levels by affecting communication distance, an animal's ability to detect calls or danger, or to forage. Sound associated with developments can also cause behavioral and/or physiological effects, damage to hearing from acoustic over-exposure, and masking of communication signals and other biologically relevant sounds (Dooling and Popper 2007). Some birds are able to shift their vocalizations to reduce the masking effects of noise. However, when shifts don't occur or are insignificant, masking may prove detrimental to the health and survival of wildlife (Barber et al. 2010). Data suggest noise increases of 3 dB to 10 dB correspond to 30 percent to 90 percent reductions in alerting distances for wildlife, respectively (Barber et al. 2010).

The National Park Service has been investigating potential impacts to wildlife due to alterations in sound level and type. However, further research is needed to better understand this potential impact. Research may include: how wind facilities affect background sound levels; whether masking, disturbance, and acoustical fragmentation occur; and how turbine, construction, and maintenance sound levels can vary by topographic area.

2. Levels of fatality beyond those predicted

More intensive post-construction fatality studies may be used to determine relationships between fatalities and weather, wind speed or other covariates, which usually require daily carcass searches. Fatalities determined to have occurred the previous night can be correlated with that night's weather or turbine characteristics to establish important relationships that can then be used to evaluate the most effective times and conditions to implement measures to reduce collision fatality at the project.

3. Measures to address fatalities

The efficacy of operational modifications (e.g. changing turbine cut-in speed) of a project to reduce collision fatalities has only recently been evaluated (Arnett et al. 2009, Baerwald et al 2009). Operational modifications and other measures to address fatalities should be applied only at sites where collision fatalities are predicted or demonstrated to be high.

Tier 5 Studies and Research

Developers may be asked to conduct a study on an experimental mitigation technique, such as differences in turbine cut-in speed to reduce bat fatalities. Such techniques may show promise in mitigating the impacts of wind energy development to wildlife, but may have not been shown to have broad applicability for mitigation. Such techniques should not be routinely applied to projects, but application at appropriate sites will contribute to the breadth of knowledge regarding the efficacy of such measures in addressing collision fatalities. In addition, studies involving multiple sites and academic researchers can provide more robust research results, and such studies take more time and resources than are appropriately carried out by one developer at a single site. Examples below demonstrate collaborative research efforts to address displacement, operational modifications, and population level impacts.

1. Displacement Studies

Researchers at Kansas State University, as part of the NWCC GS3C, have begun a multi-year telemetry study to evaluate the effects of three proposed projects on displacement and demographic parameters (survival, nest success, brood success, fecundity) of greater prairie chickens (*Tympanuchus cupido*) in Kansas. Studies are intended to evaluate whether: 1) lek attendance is affected by wind energy development, 2) greater prairie-chickens avoid wind turbines and/or other anthropogenic features, and 3) wind energy development reduces nest success or chick survival.

The study combines use of data collected at three proposed projects and reference areas, and the BACI design has been used to assess impacts on demographic parameters. Several hundred birds have been radio marked on all sites combined to obtain baseline data on both the reference areas and project sites. Birds are located frequently to determine home ranges and habitat use prior to project development so that displacement can be measured once the facilities are constructed. In addition, data are collected on survival of radio-marked birds as well as nest success, fledgling success, and fecundity (the number of female offspring produced per adult female). The first year of post-construction data were collected in 2009.

Erickson et al. (2004) evaluated the displacement effect of a large wind energy facility in the Pacific Northwest. The study was conducted in a relatively homogeneous grassland landscape. Erickson et al. (2004) conducted surveys of breeding grassland birds along 300 meter transects perpendicular to strings of wind turbines. Surveys were conducted prior to construction and after commercial operation. The basic study design follows the Impact Gradient Design (Morrison et al. 2008) and in this application, conformed to a special case of BACI where areas at the distal end of each transect were considered controls (i.e., beyond the influence of the turbines). In this study, there is no attempt to census birds in the area, and observations per survey are used as an index of abundance. Additionally, the impact-gradient study design resulted in less effort than a BACI design with offsite control areas. Erickson et al. (2004) found that grassland passerines as a group, as well as grasshopper sparrows and western meadowlarks, showed reduced use in the first 50 meter segment nearest the turbine string. About half of the area within that segment, however, had disturbed vegetation and separation of behavior avoidance from physical loss of habitat in this portion of the area was impossible. Horned larks and savannah sparrows (*Passerculus sandwichensis*) appeared unaffected. The impact gradient design is best used when the study area is relatively small and homogeneous.

2. Operational Modifications to Reduce Collision Fatality

Arnett et al. (2009) conducted studies on the effectiveness of changing turbine cut-in speed on reducing bat fatality at wind turbines at the Casselman Wind Project in Somerset County, Pennsylvania. Their objectives were to: 1) determine the difference in bat fatalities at turbines with different cut-in-speeds relative to fully operational turbines, and 2) determine the economic costs of the experiment and estimated costs for the entire area of interest under different curtailment prescriptions and timeframes. Arnett et al. (2009) reported substantial reductions in bat fatalities with relatively modest power losses.

In Kenedy County, Texas, investigators are refining and testing a real-time curtailment protocol. The projects use an avian profiling radar system to detect approaching "flying vertebrates" (birds and bats), primarily during spring and fall bird and bat migrations. The blades automatically idle when risk reaches a certain level and weather conditions are particularly risky. Based on estimates of the number and timing of migrating raptors, feathering (real-time curtailment) experiments are underway in Tehuantepec, Mexico, where raptor migration through a mountain pass is extensive.

Other tools, such as thermal imaging (Horn et al. 2008) or acoustic detectors (Kunz et al. 2007), have been used to quantify post-construction bat activity in relation to weather and turbine characteristics for improving operational mitigation efforts. For example, at the Mountaineer project in 2003, Tier 4 studies (weekly searches at every turbine) demonstrated unanticipated and high levels of bat fatalities (Kerns and Kerlinger 2004). Daily searches were instituted in 2004 and revealed that fatalities were strongly associated with low-average-wind-speed nights, thus providing a basis for testing operational modifications (Arnett 2005, Arnett et al. 2008). The program also included behavioral observations using thermal imaging that demonstrated higher bat activity at lower wind speeds (Horn et al. 2008).

Studies are currently underway to design and test the efficacy of an acoustic deterrent device to reduce bat fatalities at wind facilities (E.B. Arnett, Bat Conservation International, under the auspices of BWEC). Prototypes of the device have been tested in the laboratory and in the field with some success. Spanjer (2006) tested the response of big brown bats (*Eptesicus fuscus*) to a prototype eight speaker deterrent emitting broadband white noise at frequencies from 12.5–112.5 kHz and found that during non-feeding trials, bats landed in the quadrant containing the device significantly less when it was broadcasting broadband noise. Spanjer (2006) also reported that during feeding trials, bats never successfully took a tethered mealworm when the device broadcast sound, but captured mealworms near the device in about 1/3 of trials when it was silent. Szewczak and Arnett (2006, 2007) tested the same acoustic deterrent in the field and found that when placed by the edge of a small pond where nightly bat activity was consistent, activity dropped significantly on nights when the deterrent was activated. Horn et al. (2007) tested the effectiveness of a larger, more powerful version of this deterrent device on reducing nightly bat activity and found mixed results. In 2009, a new prototype device was developed and tested at a project in Pennsylvania. Ten turbines were fitted with deterrent devices, daily fatality searches were conducted, and fatality estimates were compared with those from 15 turbines without deterrents (i.e., controls) to determine if bat fatalities were reduced. This experiment found that estimated bat fatalities per turbine were 20 to 53 percent lower at treatment turbines compared to controls. More experimentation is required. At the present time, there is not an operational deterrent available that has demonstrated effective reductions in bat kills (E. B. Arnett, Bat Conservation International, unpublished data).

3. Assessment of Population-level Impacts

The Altamont Pass Wind Resource Area (APWRA) has been the subject of intensive scrutiny because of avian fatalities, especially for raptors, in an area encompassing more than 5,000 wind turbines (e.g., Orloff and Flannery 1992; Smallwood and Thelander 2004, 2005). To assess population-level effects of long lived raptors, Hunt (2002) completed a four-year telemetry study of golden eagles at the APWRA and concluded that while the population is self-sustaining, fatalities resulting from wind-energy production were of concern because the population apparently depends on floaters from the local population and/or immigration of eagles from other subpopulations to fill vacant territories. Hunt conducted follow-up surveys in 2005 (Hunt and Hunt 2006) and determined that all 58 territories occupied by eagle pairs in 2000 were also occupied in 2005.

Chapter 7

Best Management Practices

Site Construction: Site Development and Construction Best Management Practices

During site planning and development, careful attention to reducing risk of adverse impacts to species of concern from wind energy projects, through careful site selection and facility design, is recommended. The following BMPs can assist a developer in the planning process to reduce potential impacts to species of concern. Use of these BMPs should ensure that the potentially adverse impacts to most species of concern and their habitats present at many project sites would be reduced, although compensatory mitigation may be appropriate at a project level to address significant site-specific concerns and pre-construction study results.

These BMPs will evolve over time as additional experience, learning, monitoring and research becomes available on how to best minimize wildlife and habitat impacts from wind energy projects. Service should work with the industry, stakeholders and states to evaluate, revise and update these BMPs on a periodic basis, and the Service should maintain a readily available publication of recommended, generally accepted best practices.

1. Minimize, to the extent practicable, the area disturbed by pre-construction site monitoring and testing activities and installations.
2. Avoid locating wind energy facilities in areas identified as having a demonstrated and unmitigatable high risk to birds and bats.
3. Use available data from state and federal agencies, and other sources (which could include maps or databases), that show the location of sensitive resources and the results of Tier 2 and/or 3 studies to establish the layout of roads, power lines, fences, and other infrastructure.
4. Use native species when seeding or planting during restoration.
5. To reduce avian collisions, place low and medium voltage connecting power lines associated with the wind energy development underground to the extent possible, unless burial of the

lines is prohibitively expensive (e.g., where shallow bedrock exists) or where greater adverse impacts to biological resources would result:

a. Overhead lines may be acceptable if sited away from high bird crossing locations, to the extent practicable, such as between roosting and feeding areas or between lakes, rivers, prairie grouse and sage grouse leks, and nesting habitats. To the extent practicable, the lines should be marked in accordance with Avian Power Line Interaction Committee (APLIC) collision guidelines.

b. Overhead lines may be used when the lines parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced.

c. Above-ground low and medium voltage lines, transformers and conductors should follow the 2006 or most recent APLIC "Suggested Practices for Avian Protection on Power Lines."

6. Avoid guyed communication towers and permanent met towers at wind energy project sites. If guy wires are necessary, bird flight diverters or high visibility marking devices should be used.

7. Use construction and management practices to minimize activities that may attract prey and predators to the wind energy facility.

8. Employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights, to meet Federal Aviation Administration (FAA) requirements for visibility lighting of wind turbines, permanent met towers, and communication towers. Only a portion of the turbines within the wind project should be lighted, and all pilot warning lights should fire synchronously.

9. Keep lighting at both operation and maintenance facilities and substations located within half a mile of the turbines to the minimum required:

a. Use lights with motion or heat sensors and switches to keep lights off when not required.

b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.

   c. Minimize use of high-intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.

10. Establish non-disturbance buffer zones to protect sensitive habitats or areas of high risk for species of concern identified in pre-construction studies. Determine the extent of the buffer zone in consultation with the Service and state, local and tribal wildlife biologists, and land management agencies (e.g., U.S. Bureau of Land Management (BLM) and U.S. Forest Service (USFS)), or other credible experts as appropriate.

11. Locate turbines to avoid separating bird and bat species of concern from their daily roosting, feeding, or nesting sites if documented that the turbines' presence poses a risk to species.

12. Avoid impacts to hydrology and stream morphology, especially where federal or state-listed aquatic or riparian species may be involved.

13. When practical use tubular towers or best available technology to reduce ability of birds to perch and to reduce risk of collision.

14. Minimize the number and length of access roads; use existing roads when feasible.

15. Minimize impacts to wetlands and water resources by following all applicable provisions of the Clean Water Act (33 USC 1251-1387) and the Rivers and Harbors Act (33 USC 301 et seq.); for instance, by developing and implementing a storm water management plan and taking measures to reduce erosion.

16. Reduce vehicle collision risk to wildlife by instructing project personnel to drive at appropriate speeds, be alert for wildlife, and use additional caution in low visibility conditions.

17. Instruct employees, contractors, and site visitors to avoid harassing or disturbing wildlife, particularly during reproductive seasons.

18. Reduce fire hazard from vehicles and human activities (instruct employees to use spark arrestors on power equipment, ensure that no metal parts are dragging from vehicles, use caution with open flame, cigarettes, etc.).

19. Follow federal and state measures for handling toxic substances to minimize danger to water and wildlife resources from spills.

20. Reduce the introduction and spread of invasive species by following applicable local policies for noxious weed control, cleaning vehicles and equipment arriving from areas with known invasive species issues, using locally sourced topsoil, and monitoring for and rapidly removing noxious weeds at least annually.
21. Utilize pest and weed control measures as specified by county or state requirements, or by applicable federal agency requirements (such as Integrated Pest Management) when federal policies apply.

Retrofitting, Repowering, and Decommissioning: Best Management Practices

As with project construction, these Guidelines offer BMPs for the retrofitting, repowering, and decommissioning phases of wind energy projects.

Retrofitting

Retrofitting is defined as replacing portions of existing wind turbines or project facilities so that at least part of the original turbine, tower, electrical infrastructure or foundation is being utilized. Retrofitting BMPs include:

1. Retrofitting of turbines should use installation techniques that minimize new site disturbance, soil erosion, and removal of vegetation of habitat value.
2. Retrofits should employ shielded, separated or insulated electrical conductors that minimize electrocution risk to avian wildlife per APLIC (2006).
3. Retrofit designs should prevent nests or bird perches from being established in or on the wind turbine or tower.
4. FAA visibility lighting of wind turbines should employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights.
5. Lighting at both operation and maintenance facilities and substations located within half a mile of the turbines should be kept to the minimum required:
    a. Use lights with motion or heat sensors and switches to keep lights off when not required.

   b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.
   c. Minimize use of high intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.
6. Remove wind turbines when they are no longer cost effective to retrofit.

Repowering

Repowering may include removal and replacement of turbines and associated infrastructure. BMPs include:

1. To the greatest extent practicable, existing roads, disturbed areas and turbine strings should be re-used in repower layouts.
2. Roads and facilities that are no longer needed should be demolished, removed, and their footprint stabilized and re-seeded with native plants appropriate for the soil conditions and adjacent habitat and of local seed sources where feasible, per landowner requirements and commitments.
3. Existing substations and ancillary facilities should be re-used in repowering projects to the extent practicable.
4. Existing overhead lines may be acceptable if located away from high bird crossing locations, such as between roosting and feeding areas, or between lakes, rivers and nesting areas. Overhead lines may be used when they parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced.
5. Above-ground low and medium voltage lines, transformers and conductors should follow the 2006 or most recent APLIC "Suggested Practices for Avian Protection on Power Lines."
6. Guyed structures should be avoided. If use of guy wires is absolutely necessary, they should be treated with bird flight diverters or high visibility marking devices, or are located where known low bird use will occur.
7. FAA visibility lighting of wind turbines should employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights.

8. Lighting at both operation and maintenance facilities and substations located within ½ mile of the turbines should be kept to the minimum required.
    a. Use lights with motion or heat sensors and switches to keep lights off when not required.
    b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.
    c. Minimize use of high intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.

Decommissioning

Decommissioning is the cessation of wind energy operations and removal of all associated equipment, roads, and other infrastructure. The land is then used for another activity. During decommissioning, contractors and facility operators should apply BMPs for road grading and native plant re-establishment to ensure that erosion and overland flows are managed to restore pre-construction landscape conditions. The facility operator, in conjunction with the landowner and state and federal wildlife agencies, should restore the natural hydrology and plant community to the greatest extent practical.

1. Decommissioning methods should minimize new site disturbance and removal of native vegetation, to the greatest extent practicable.
2. Foundations should be removed to a depth of two feet below surrounding grade, and covered with soil to allow adequate root penetration for native plants, and so that subsurface structures do not substantially disrupt ground water movements.
3. If topsoils are removed during decommissioning, they should be stockpiled and used as topsoil when restoring plant communities. Once decommissioning activity is complete, topsoils should be restored to assist in establishing and maintaining pre-construction native plant communities to the extent possible, consistent with landowner objectives.
4. Soil should be stabilized and re-vegetated with native plants appropriate for the soil conditions and adjacent habitat, and of local seed sources where feasible, consistent with landowner objectives.

5. Surface water flows should be restored to pre-disturbance conditions, including removal of stream crossings, roads, and pads, consistent with storm water management objectives and requirements.
6. Surveys should be conducted by qualified experts to detect invasive plants, and comprehensive approaches to controlling any detected plants should be implemented and maintained as long as necessary.
7. Overhead pole lines that are no longer needed should be removed.
8. After decommissioning, erosion control measures should be installed in all disturbance areas where potential for erosion exists, consistent with storm water management objectives and requirements.
9. Fencing should be removed unless the landowner will be utilizing the fence.
10. Petroleum product leaks and chemical releases should be remediated prior to completion of decommissioning.

Chapter 8

Mitigation

In its Mitigation Policy (501 FW 2 of the Service Manual, available at http://www.fws.gov/policy/manuals/), the Service adopted the Council on Environmental Quality's definition of "mitigation." *See* 40 C.F.R. 1508.20. These Guidelines provide a simplified version of that definition and define "mitigation" as avoiding and minimizing adverse effects, and when appropriate, compensating for adverse effects. When used in this document, the priority of mitigation activities is to avoid and minimize adverse effects before resorting to compensation. Because avoidance is the first step in achieving mitigation, the importance of early consultation with the Service cannot be overstated. The amount of compensation will depend on the effectiveness of any avoidance and minimization measures undertaken. If a proposed wind development is poorly sited with regard to wildlife effects, the most important mitigation opportunity is largely lost and the remaining options can be expensive, with substantially greater environmental effects. The Service will work with developers to report on the success of industry's mitigation efforts.

During the early communication process the Service, the developer, and other relevant agencies will identify affected species and their habitats that may occur in the area that might be affected by project development. The objective is to avoid, minimize, and/or compensate for adverse effects to affected species, and when appropriate, to provide compensation for unavoidable adverse effects. Avoidance, minimization, and compensation may be required elements of other efforts including conservation plans, regulations, or conditions of permit compliance. It is expected that the developer will work with the Service and other appropriate entities and subject experts to agree on mitigation strategies. It is in the best interest of all parties to cooperate early in the project siting and design process to identify up front where mitigation may be appropriate and feasible. This will avoid unnecessary project delays and allows for incorporation of the mitigation into the project design. Early coordination can help avoid substantial investment costs in projects that may have poor chances of successful permitting or may come with high mitigation expenses, and instead facilitate investment in projects with a high probability of success.

Ideally, project impact assessment is a cooperative effort involving the developer, the Service, tribes, local authorities, and state resource agencies. The Service does not expect developers to provide compensation for the same habitat loss more than once. But the Service, state resource agencies, tribe, local authorities, state and federal land management agencies may have different species or habitats of concern, according to their responsibilities and statutory authorities. Hence, one entity may seek mitigation for a different group of species or habitat than does another. Compensation is most often appropriate for habitat loss and only under limited circumstances or for direct take of wildlife (e.g., Habitat Conservation Plans). In certain limited situations, compensation may be appropriate. Developers should consult with the Service and state agency prior to initiating such an approach.

More typically, avoidance and minimization is utilized to offset direct take. E.O. 13186, which addresses responsibilities of federal agencies to protect migratory birds, includes a directive to federal agencies to restore and enhance the habitat of migratory birds as practicable. So for any wind projects with a federal nexus, E.O. 13186 provides a basis and a rationale for mitigating for the loss of migratory bird habitat that result from developing the project.

Regulations concerning eagle take permits in 50 CFR 22.26 and 50 CFR 22.27 may both allow for compensation as part of permit issuance. Compensation may be a condition of permit issuance in cases of nest removal, disturbance or take resulting in mortality that will likely occur over several seasons, result in permanent abandonment of one or more breeding territories, have large scale impacts, occur at multiple locations, or otherwise contribute to cumulative negative effects. The draft ECP Guidance has additional information on the use of compensation for programmatic permits.

ESA also has provisions that allow for compensation through the issuance of an Incidental Take Permit. Under ESA, mitigation measures are determined on a case by case basis, and are based on the needs of the species and the types of effects anticipated. If a federal nexus exists, or if a developer chooses to seek an ITP under ESA, then effects to listed species need to be evaluated through the Section 7 and/or Section10 processes. If an ITP is requested, it and the associated

HCP must provide for minimization and mitigation to the maximum extent practicable, in addition to meeting other necessary criteria for permit issuance. For further information about compensation under federal laws administered by the Service, see the Service's Habitat and Resource Conservation website http://www.fws.gov/habitatconservation.

When adverse effects to important habitats cannot be avoided, developers should pursue opportunities to minimize adverse effects to the fullest extent practicable. For example, it may not be possible to avoid removing some forested habitat for a turbine string, but it may be possible to reduce the total amount of forest habitat removed through alternative placement of other structures and to provide compensation for the habitat loss.

In cases where adverse effects cannot be avoided or minimized, it may be possible to offset all, or a portion, of these effects through compensation. One approach for compensation is the Service Mitigation Policy, which describes steps for addressing habitat loss in detail and includes information on Resource Categories to assist in considering type and amount of compensation to offset losses of habitat.

The Mitigation Policy applies to all activities of the Service with three specific exceptions:

A. Threatened or Endangered species
B. Service recommendations for completed federal projects or projects permitted or licensed prior to enactment of Service authorities, or
C. Service recommendations related to the enhancement of fish and wildlife resources.

For example, the resource goals for the following habitat resource categories are:

Resource Category 1: Avoid habitat loss
Resource Category 2: No net loss of in-kind habitat value
Resource Category 3: No net loss of out-of-kind habitat value
Resource Category 4: Minimize loss of habitat value

Under the Service Mitigation Policy, the highest priority is for mitigation to occur on-site within the project planning area. The secondary priority is for the mitigation to occur off-site. Off-site mitigation should first occur in proximity to the planning area within the same ecological region and secondarily elsewhere within the same ecological region. Generally, the Service prefers on-site mitigation over off-site mitigation because this approach most directly addresses project impacts at the location where they actually occur. However, there may be individual cases where off-site mitigation could result in greater net benefits to affected species and habitats. Developers should work with the Service in comparing benefits among multiple alternatives.

Recommended measures may include on- or off-site habitat improvement, and may consist of in-kind or out-of-kind compensation. Compensatory measures may be project-specific, species-specific, or may be part of a mitigation banking approach. It is recommended that the method for implementing compensation (e.g., fee-title acquisition, in-lieu fee, conservation easement, etc.) be determined as early in the process as possible.

If it cannot be determined that adverse effects have been adequately addressed by existing mitigation measures, additional mitigation for adverse effects from operations may need to be implemented. In some cases, a project's effects cannot be forecast with precision and the developer and the agencies may be unable to make some mitigation decisions until post-construction data have been collected.

Mitigation measures implemented post-construction, whether in addition to those implemented pre-construction or whether they are new, are appropriate elements of the tiered approach. The general terms and funding commitments for future mitigation and the triggers or thresholds for implementing such compensation should be developed at the earliest possible stage in project development. Any mitigation implemented after a project is operational should be well defined, bounded, technically feasible, and commensurate with the project effects.

Some industries, such as the electric utilities, have developed operational and deterrent measures that when properly used can avoid or minimize "take" of migratory birds. Many of these measures to avoid collision and electrocution have been scientifically tested with publication in peer-reviewed, scientific journals. We strongly encourage the wind industry to use these measures in siting, placing, and operating all power lines, including their distribution and grid-connecting transmission lines. While the Service has worked cooperatively with the electric utility industry since the early 1970s, our partnership with the commercial wind industry is a much more recent one and the state of the art regarding operation and deterrence with this industry is only evolving. At present, the primary tool available to the wind industry involves site selection. The Service strongly recommends proponents select sites with the least likelihood of encountering protected species. We acknowledge, however, that even some heavily developed, exploited sites, such as extensive areas of intensive agricultural production remain a concern relative to bat collisions and barotrauma, among others.

Chapter 9
Advancing Use, Cooperation and Effective Implementation

This chapter contains succinct discussions of a variety of policies and procedures that may affect the way wind project developers and the Service work with each other as well as with state and tribal governments and non-governmental organizations. The Service recommends that wind project developers work closely with field office staff for further elaboration of these policies and procedures.

Conflict Resolution

The Service and developers should attempt to resolve any issues arising from use of the Guidelines at the Field Office level. Deliberations should be in the context of the intent of the Guidelines and be based on the site-specific conditions and the best available data. However, if there is an issue that cannot be resolved within a timely manner at the field level, the developer and Service staff will coordinate to bring the matter up the chain of command in a stepwise manner.

Avian and Bat Protection Plan (ABPP)

A project-specific Avian and Bat Protection Plan (ABPP) documents the steps a developer takes to avoid and minimize effects to birds and bats, and (if applicable) documents compensation measures taken and incorporates adaptive management. Typically, a project-specific ABPP will document the analyses, studies, and reasoning that support progressing from one tier to the next in the tiered approach described in these draft Guidelines. Often, an ABPP will be developed in stages, over time, as analysis and studies are undertaken for each tier. It will also address the post-construction monitoring efforts for mortality and habitat effects, and may use many of the components suggested in the APLIC.

Project Interconnection Lines

The Guidelines are designed to address all elements of a wind energy facility, including the turbine string or array, access roads, ancillary buildings, and the above- and below-ground electrical lines which connect a project to the transmission system. It is recommended that the project evaluation include consideration of the wildlife- and habitat-related impacts of these electrical lines, and that the developer include measures to reduce impacts of these lines, such as those outlined in the Avian Power Line Interaction Committee (APLIC) Suggested Practices for Avian Protection on Power Lines (2006). The Guidelines are not designed to address transmission beyond the point of interconnection to the transmission system. The national grid and proposed smart grid system are beyond the scope of these Guidelines.

Confidentiality of Site Evaluation Process as Appropriate

Some aspects of the initial pre-construction risk assessment, including preliminary screening and site characterization, occur early in the development process, when land or other competitive issues limit developers' willingness to share information on projects with the public and competitors. Any consultation or coordination with agencies at this stage may include confidentiality agreements.

Collaborative Research

Much uncertainty remains about predicting risk and estimating impacts of wind energy development on wildlife. Thus there is a need for additional research to improve scientifically based decision-making when siting wind energy facilities, evaluating impacts on wildlife and habitats, and testing the efficacy of mitigation measures. More extensive studies are needed to further elucidate patterns and test hypotheses regarding possible solutions to wildlife and wind energy impacts.

It is in the interests of wind developers and wildlife agencies to improve these assessments to better avoid or minimize the impacts of wind energy development on wildlife and their habitats. Research can provide data on operational factors (e.g. wind speed, weather conditions) that are likely to result in fatalities. It could also include studies of cumulative impacts of multiple wind energy projects, or comparisons of different methods for assessing avian and bat activity relevant to predicting risk. Monitoring and research should be designed and conducted to ensure unbiased data collection that meets technical standards such as those used in peer review. Research projects may occur at the same time as project-specific Tier 4 and Tier 5 studies.

Research would usually result from collaborative efforts involving appropriate stakeholders, and is not the sole or primary responsibility of any developer. Research partnerships (e.g., Bats and Wind Energy Cooperative (BWEC)[7], Grassland and Shrub Steppe Species Collaborative (GS3C)[8]) involving diverse players will be helpful for generating common goals and objectives and adequate funding to conduct studies (Arnett and Haufler 2003). The National Wind Coordinating Collaborative (NWCC)[9], the American Wind Wildlife Institute (AWWI)[10], and the California Energy Commission (CEC)'s Public Interest Energy Research Program[11] all support research in this area.

Study sites and access will be required to design and implement research, and developers are encouraged to participate in these research efforts when possible. Subject to appropriations, the Service also should fund priority research and promote collaboration and information sharing among research efforts to advance science on wind energy-wildlife interactions, and to improve these Guidelines.

[7] www.batsandwind.org
[8] www.nationalwind.org
[9] www.nationalwind.org
[10] http://www.awwi.org
[11] http://www.energy.ca.gov/research

Service - State Coordination and Cooperation

The Service encourages states to increase compatibility between state guidelines and these voluntary guidelines, protocols, data collection methods, and recommendations relating to wildlife and wind energy. States that desire to adopt, or those that have formally adopted, wind energy siting, permitting or environmental review regulations or guidelines are encouraged to cooperate with the Service to develop consistent state level guidelines. The Service may be available to confer, coordinate and share its expertise with interested states when a state lacks its own guidance or program to address wind energy-wildlife interactions. The Service will also use states' technical resources as much as possible and as appropriate.

The Service will explore establishing a voluntary state/federal program to advance cooperation and compatibility between the Service and interested state and local governments for coordinated review of projects under both federal and state wildlife laws. The Service, and interested states, will consider using the following tools to reach agreements to foster consistency in review of projects:

- Cooperation agreements with interested state governments.

- Joint agency reviews to reduce duplication and increase coordination in project review.

- A communication mechanism:
    - To share information about prospective projects
    - To coordinate project review
    - To ensure that state and federal regulatory processes, and/or mitigation requirements are being adequately addressed
    - To ensure that species of concern and their habitats are fully addressed

- Establishing consistent and predictable joint protocols, data collection methodologies, and study requirements to satisfy project review and permitting.

- Designating a Service management contact within each Regional Office to assist Field Offices working with states and local agencies to resolve significant wildlife-related issues that cannot be resolved at the field level.

- Cooperative state/federal/industry research agreements relating to wind energy -wildlife interactions.

- States without their own guidelines should consider waiting for the Service guidelines in order to ensure compatibility with those guidelines.

The Service will explore opportunities to:

- Provide training to states.
- Foster development of a national geographic data base that identifies development-sensitive ecosystems and habitats.
- Support a national database for reporting of mortality data on a consistent basis.
- Establish national BMPs for wind energy development projects.
- Develop recommended guidance on study protocols, study techniques, and measures and metrics for use by all jurisdictions.
- Assist in identifying and obtaining funding for national research priorities.

Service - Tribal Consultation and Coordination

Indian Tribes enjoy a unique government-to-government relationship with the United States. The United States Fish and Wildlife Service (Service) recognizes Indian tribal governments as the authoritative voice regarding the management of tribal lands and resources within the framework of applicable laws. It is important to recall that many tribal traditional lands and tribal rights extend beyond reservation lands (those lands that are held in trust by the Federal government for the benefit of Indian Tribes).

The Service consults with Indian tribal governments under the authorities of Executive Order 13175 "Consultation and Coordination with Indian Tribal Governments and supporting DOI and Service policies. To this end, when it is determined that federal actions and activities may impact a Tribe's resources, rights, or ability to provide services to its membership the Service must, to the extent practicable, seek to engage the affected Tribe(s) in consultation and coordination.

Tribal Wind Energy Development on Reservation Lands:

Indian tribal governments have the authority to develop wind energy projects, permit their development, and establish relevant regulatory guidance within the framework of applicable laws.

The Service will provide technical assistance upon the request of Tribes that aim to establish regulatory guidance for wind energy development. Tribal governments are encouraged to strive for compatibility between their guidelines and the *Land-Based Wind Energy Guidelines - Recommendations on measures to avoid, minimize, and compensate for effects to fish, wildlife, and their habitats.*

Tribal Wind Energy Development on Lands that are not held in Trust:

Indian tribal governments may wish to develop wind energy projects on lands that are not held in trust status. In such cases, the Tribe will be required to coordinate with agencies other than the Service. At the request of a Tribe the Service may facilitate discussions with other regulatory organizations. The Service may also lend its expertise in these collaborative efforts to help determine the extent to which tribal resource management plans and priorities can be incorporated into established regulatory protocols.

Non-Tribal Wind Energy Development – Consultation with Indian Tribal Governments

When a wind energy project is proposed that may affect a Tribe's resources, rights, or ability to provide services to its membership, the Service may seek to engage the affected Tribe(s) in consultation and coordination. In sighting a proposed project that has a Federal nexus, it is incumbent upon the regulatory agency, to the extent practicable, to notify potentially affected Tribes of the proposed activity. If the Service or other federal agency determines that a project may affect a Tribe(s), they should notify the Tribe(s) of the action. At the request of a Tribe the Service may facilitate and lend its expertise in collaborating with other organizations to help determine the extent to which tribal resource management plans and priorities can be incorporated into established regulatory protocols or project implementation. This process ideally should be agreed to by all involved parties.

In the consultative process, Tribes should be engaged as soon as possible when a decision which may affect a Tribe(s) is imminent. Decisions made that affect Indian Tribal governments without adequate Federal effort to engage Tribe(s) in consultation can been overturned by the courts - - see Quechan Tribe v. United States Department of the Interior, 10cv2241 LAB (CAB), 2010 WL 5113197 (S.D. Cal. Dec. 15, 2010). When a tribal government is consulted, it is neither required, nor expected that all of the Tribe's issues can be resolved in its favor. However, the Service must listen and may not arbitrarily dismiss concerns of the tribal government. Regional Native American Liaisons are able to provide in-house guidance as to government-to-government consultation processes. (See *Section D. USFWS-State Coordination and Cooperation*, above).

Non-Governmental Organization Actions

If a specific project involves actions at the local, state, or federal level that provide opportunities for public participation, non-governmental organizations (NGOs) can provide meaningful contributions to the discussion of biological issues associated with that project, through the normal processes such as scoping, testimony at public meetings, and comment processes. In the absence of formal public process, there are many NGOs that have substantial scientific capabilities and may have resources that could contribute productively to the siting of wind energy projects. Several NGOs have made significant contributions to the understanding of the importance of particular geographic areas to wildlife in the United States. This work has benefited and continues to benefit from extensive research efforts and from associations with highly qualified biologists. NGO expertise can – as can scientific expertise in the academic or private consulting sectors – serve highly constructive purposes. These can include:

- Providing information to help identify environmentally sensitive areas, during the screening phases of site selection (Tiers 1 and 2, as described in this document)
- Providing feedback to developers and agencies with respect to specific sites and site and impact assessment efforts
- Helping developers and agencies design and implement mitigation or offset strategies
- Participating in the defining, assessing, funding, and implementation of research efforts in support of improved predictors of risk, impact assessments and effective responses
- Articulating challenges, concerns, and successes to diverse audiences

Non-Governmental Organization Conservation Lands

Implementation of these Guidelines by Service and other state agencies will recognize that lands owned and managed by non-government conservation organizations represent a significant investment that generally supports the mission of state and federal wildlife agencies. Many of these lands represent an investment of federal conservation funds, through partnerships between agencies and NGOs. These considerations merit extra care in the avoidance of wind energy development impacts to these lands. In order to exercise this care, the Service and allied agencies can coordinate and consult with NGOs that own lands or easements which might reasonably be impacted by a project under review.

Appendix A

Glossary

Accuracy – The agreement between a measurement and the true or correct value.

Adaptive management – An iterative decision process that promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. The term as used in the recommendations and the Guidelines specifically refers to "passive" adaptive management, in which alternative management activities are assessed, and the best option is designed, implemented, and evaluated.

Anthropogenic – Resulting from the influence of human beings on nature.

Area of interest – For most projects, the area where wind turbines and meteorological (met) towers are proposed or expected to be sited, and the area of potential impact.

Avian – Pertaining to or characteristic of birds.

Avoid – To not take an action or parts of an action to avert the potential effects of the action or parts thereof. First of three components of "mitigation," as defined in Service Mitigation Policy. (*See* **mitigation**.)

Before-after/control-impact (BACI) – A study design that involves comparisons of observational data, such as bird counts, before and after an environmental disturbance in a disturbed and undisturbed site. This study design allows a researcher to assess the effects of constructing and operating a wind turbine by comparing data from the "control" sites (before and undisturbed) with the "treatment" sites (after and disturbed).

Best management practices (BMPs) – Methods that have been determined by the stakeholders to be the most effective, practicable means of avoiding or minimizing significant adverse impacts to individual species, their habitats or an ecosystem, based on the best available information.

Buffer zone – A neutral zone surrounding a resource designed to protect the resource from adverse impact, and/or a zone surrounding an existing or proposed wind energy project for the purposes of data collection and/or impact estimation.

Community-scale – Wind energy projects greater than 100kW where the electricity is sold rather than used on-site. This category can include large arrays of 100 or more turbines owned by large corporations, a single locally-owned wind turbine greater than 100kW in size, or anything in between.

Comparable site – A site similar to the project site with respect to topography, vegetation, and the species under consideration.

Compensatory mitigation – Replacement of project-induced losses to fish and wildlife resources. Substitution or offsetting of fish and wildlife resource losses with resources considered to be of equivalent biological value.

- **In-kind –** Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate to those lost.
- **Out-of-kind –** Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically or biologically different from those lost. This may include conservation or mitigation banking, research or other options.

Cost effective – Economical in terms of tangible benefits produced by money spent.

Covariate – Uncontrolled random variables that influence a response to a treatment or impact, but do not interact with any of the treatments or impacts being tested.

Critical habitat – For listed species, consists of the specific areas designated by rule making pursuant to Section 4 of the Endangered Species Act and displayed in 50 CFR § 17.11 and 17.12.

Cumulative impacts – *See* **impact**.

Displacement – The loss of habitat as result of an animal's behavioral avoidance of otherwise suitable habitat. Displacement may be short-term, during the construction phase of a project, temporary as a result of habituation, or long-term, for the life of the project.

Distributed wind – Small and mid-sized turbines between 1 kilowatt and 1 megawatt for distributed wind applications, including energy generation for homes, businesses, farms, and community wind projects, intended to off-set all or a portion of on-site energy consumption

Ecosystem – A system formed by the interaction of a community of organisms with their physical and chemical environment. All of the biotic elements (i.e., species, populations, and communities) and abiotic elements (i.e., land, air, water, energy) interacting in a given geographic area so that a flow of energy leads to a clearly defined trophic structure, biotic diversity, and material cycles. Service Mitigation Policy adopted definition from E. P. Odum 1971 *Fundamentals of Ecology.*

Endangered species – *See* **listed species**.

Extirpation – The species ceases to exist in a given location; the species still exists elsewhere.

Fatality – An individual instance of death.

Fatality rate – The ratio of the number of individual deaths to some parameter of interest such as megawatts of energy produced, the number of turbines in a wind project, the number of individuals exposed, etc, within a specified unit of time.

Feathering – A form of curtailment for wind turbines that involves either reducing the angle of individual blades into the wind, thereby reducing rotor speed, or turning the whole unit out of the wind. When rotors are feathered, they are pitched parallel to the wind, essentially making them stationary.

Federal action agency – A department, bureau, agency or instrumentality of the United States which plans, constructs, operates or maintains a project, or which reviews, plans for or approves a permit, lease or license for projects, or manages federal lands.

Federally listed species – *See* **listed species**.

Footprint – The geographic area occupied by the actual infrastructure of a project such as wind turbines, access roads, substation, overhead and underground electrical lines, and buildings.

G1 (Global Conservation Status Ranking) Critically Imperiled – At very high risk of extinction due to extreme rarity (often five or fewer populations), very steep declines, or other factors.

G2 (Global Conservation Status Ranking) Imperiled – At high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors.

G3 (Global Conservation Status Ranking) Vulnerable – At moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors.

Guy wire – Wires used to secure wind turbines or meteorological towers that are not self-supporting.

Habitat – The area which provides direct support for a given species, including adequate food, water, space, and cover necessary for survival.

Habitat fragmentation – The separation of a block of habitat for a species into segments, such that the genetic or demographic viability of the populations surviving in the remaining habitat segments is reduced.

Impact – An effect or effects on natural resources and on the components, structures, and functioning of affected ecosystems.
- **Cumulative –** Changes in the environment caused by the aggregate of past, present and reasonably foreseeable future actions on a given resource or ecosystem.
- **Direct –** Effects on individual species and their habitats caused by the action, and occur at the same time and place.
- **Indirect impact –** Effects caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.

Infill – Add an additional phase to the existing project, or build a new project adjacent to existing projects.

In-kind compensatory mitigation – See **compensatory mitigation.**

Intact habitat – An expanse of habitat for a species or landscape scale feature, unbroken with respect to its value for the species or for society.

Intact landscape – Relatively undisturbed areas characterized by maintenance of most original ecological processes and by communities with most of their original native species still present.

Lattice design – A wind turbine support structure design characterized by horizontal or diagonal lattice of bars forming a tower rather than a single tubular support for the nacelle and rotor.

Lead agency – Agency that is responsible for federal or non-federal regulatory or environmental assessment actions.

Lek – A traditional site commonly used year after year by males of certain species of birds (e.g., greater and lesser prairie-chickens, sage and sharp-tailed grouse, and buff-breasted sandpiper), within which the males display communally to attract and compete for female mates, and where breeding occurs.

Listed species – Any species of fish, wildlife or plant that has been determined to be endangered or threatened under section 4 of the Endangered Species Act (50 CFR §402.02), or similarly designated by state law or rule.

Local population – A subdivision of a population of animals or plants of a particular species that is in relative proximity to a project.

Loss – As used in this document, a change in wildlife habitat due to human activities that is considered adverse and: 1) reduces the biological value of that habitat for species of concern; 2) reduces population numbers of species of concern; 3) increases population numbers of invasive or exotic species; or 4) reduces the human use of those species of concern.

Megawatt (MW) – A measurement of electricity-generating capacity equivalent to 1,000 kilowatts (kW), or 1,000,000 watts.

Migration – Regular movements of wildlife between their seasonal ranges necessary for completion of the species lifecycle.

Migration corridor – Migration routes and/or corridors are the relatively predictable pathways that a migratory species travel between seasonal ranges, usually breeding and wintering grounds.

Migration stopovers – Areas where congregations of birds assemble during migration, and supply high densities of food, such as wetlands and associated habitats.

Minimize – To reduce to the smallest practicable amount or degree.

Mitigation – (*Specific to these Guidelines)* Avoiding or minimizing significant adverse impacts, and when appropriate, compensating for unavoidable significant adverse impacts.

Monitoring – (1) A process of project oversight such as checking to see if activities were conducted as agreed or required; 92) making measurements of uncontrolled events at one or more points in space or time with space and time being the only experimental variable or treatment; (3) making measurements and evaluations through time that are done for a specific purpose, such as to check status and/or trends or the progress towards a management objective.

Mortality rate – Population death rate, typically expressed as the ratio of deaths per 100,000 individuals in the population per year (or some other time period).

Operational modification – Deliberate changes to wind energy project operating protocols, such as the wind speed at which turbines "cut in" or begin generating power, undertaken with the object of reducing collision fatalities.

Passerine – Describes birds that are members of the Order *Passeriformes*, typically called "songbirds."

Population – A demographically and genetically self-sustaining group of animals and/or plants of a particular species.

Practicable – Capable of being done or accomplished; feasible.

Prairie grouse – A group of gallinaceous birds, includes the greater prairie-chicken, the lesser prairie-chicken, and the sharp-tailed grouse, occurring in the Great Plains and northwestern areas of North America.

Project area – The area that includes the project site as well as contiguous land that shares relevant characteristics.

Project commencement – The point in time when a developer begins its preliminary evaluation of a broad geographic area to assess the general ecological context of a potential site or sites for wind energy project(s). For example, this may include the time at which an option is acquired to secure real estate interests, an application for federal land use has been filed, or land has been purchased.

Project Site – The land that is included in the project where development occurs or is proposed to occur.

Project transmission lines – Electrical lines built and owned by a project developer.

Raptor – As defined by the American Ornithological Union, a group of predatory birds including hawks, eagles, falcons, osprey, kites, owls, vultures and the California condor.

Relative abundance – The number of organisms of a particular kind in comparison to the total number of organisms within a given area or community.

Risk – The likelihood that adverse effects may occur to individual animals or populations of species of concern, as a result of development and operation of a wind energy project. For detailed discussion of risk and risk assessment as used in this document see Chapter Two-B.

Rotor – The part of a wind turbine that interacts with wind to produce energy. Consists of the turbine's blades and the hub to which the blades attach.

Rotor-swept area – The area of the circle or volume of the sphere swept by the turbine blades.

Rotor-swept zone – The altitude within a wind energy project which is bounded by the upper and lower limits of the rotor-swept area and the spatial extent of the project.

S1 (Subnational Conservation Status Ranking) Critically Imperiled – Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.

S2 (Subnational Conservation Status Ranking) Imperiled – Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction**.**

S3 (Subnational Conservation Status Ranking) Vulnerable – Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.

Sage grouse – A large gallinaceous bird living in the sage steppe areas of the intermountain west, including the greater sage grouse and Gunnison's sage grouse.

Significant – (For purposes of impacts to species of concern, as used in these Guidelines; adopted from *The Council on Environmental Quality Definitions, 40 CFR 1500-1508)* Significant shall be defined to include both context and intensity. Context means that the significance of an action may consider the affected region and the locality. In the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the state or the country as a whole. Both short- and long-term effects are relevant. Intensity refers to the severity of impact, and would often include consideration of the degree to which the proposed action affects wetlands, wildlife populations, wild and scenic rivers, and ecologically critical areas. Considerations of significance include the following:

- Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment.
- The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.

Comment [UF&WS5]: Note for FAC: We request further discussion regarding this definition.

- Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment.

Species of concern – For a particular wind energy project, any species which 1) is listed as an endangered, threatened or candidate species under the Endangered Species Act, is subject to the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act, or is designated by law, regulation or other formal process for protection and/or management by the relevant agency or other authority, or has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the project.

Species of habitat fragmentation concern – Species of concern whose genetic or demographic viability is reduced by separation of their habitats into smaller blocks, thereby reducing connectivity, and for which habitat fragmentation from a wind energy project may create significant barriers to genetic or demographic viability of the affected population.

String – A number of wind turbines oriented in close proximity to one another that are usually sited in a line, such as along a ridgeline.

Strobe – Light consisting of pulses that are high in intensity and short in duration.

Threatened species – *See* **listed species**.

Tubular design – A type of wind turbine support structure for the nacelle and rotor that is cylindrical rather than lattice.

Turbine height – The distance from the ground to the highest point reached by the tip of the blades of a wind turbine.

Utility-scale – Generally, a wind energy project that produces energy for off-site use, larger in scale and MW capacity than community-scale or distributed wind energy projects.

Voltage (low and medium) – Low voltages are generally below 600 volts, medium voltages are commonly on distribution electrical lines, typically between 600 volts and 110 kV, and voltages above 110 kV are considered high voltages.

Wildlife – Birds, fishes, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent.

Wildlife management plan – A document describing actions taken to identify resources that may be impacted by proposed development; measures to mitigate for any significant adverse impacts; any post-construction monitoring; and any other studies that may be carried out by the developer.

Wind turbine – A machine for converting the kinetic energy in wind into mechanical energy, which is then converted to electricity.

Appendix B

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Appendix C

Metrics and Methods Tools
For Assessing Impacts to Birds and Bats And
Addressing Episodic Mortality Events

The following list of guidelines for performing studies based on the (from 1999 to present) best available technologies and best management practices for conducting research and monitoring.

Anderson, et al. 1999. Studying wind energy/bird interactions: a guidance document. Metrics and methods for determining or monitoring potential impacts on birds at existing and proposed wind energy sites. Avian Subcommittee, National Wind Coordinating Committee, 93 pp. Available at www.nationalwind.org, go to publications, wildlife/wind interactions, and archives for the entire document. These "tools" primarily address diurnally active migratory birds.

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